

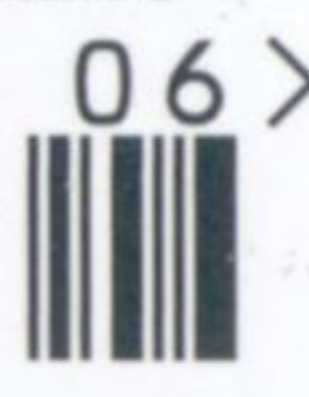
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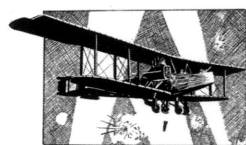
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- RAAF Mirages • Handley Page 0/400 • Hawk 200 • Gulf War Markings
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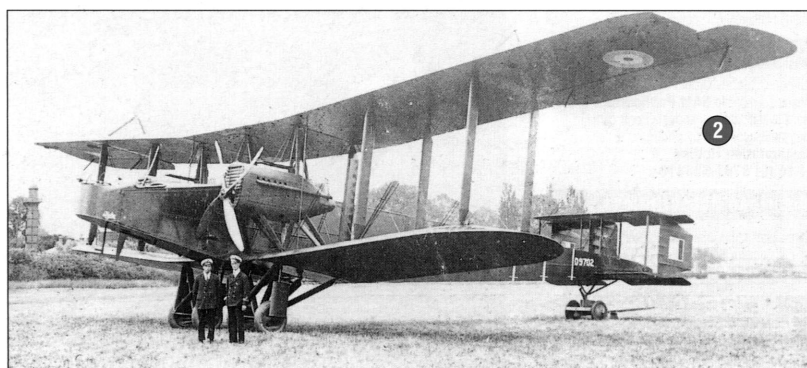
Aspects of the Handley Page O/400

by Harry Woodman

During WWI the Royal Naval Air Service was responsible for some of the more adventurous and anticipatory initiatives in operations and equipment, the Handley Page bomber being one of these. The concept of a large multi-engined aeroplane capable of flying over long distances and delivering a heavy bomb load was quite alien in 1914 outside of popular fiction, except in Russia. In 1913 Igor Sikorsky had designed and flown such a machine and developed a more powerful aeroplane and by September 1914 the first two were in service.

The Handley Page company's Chief Designer (or engineer as they were known then) was one George R. Volkert who, with his team, was presented with the task of fulfilling a request from the Admiralty Air Department. The Head of this department was Commander Murray F. Sueter who shared the enthusiasm of Commander C.R. Samson recently returned from an exciting period of very active service as commander of an RN Force in Belgium. Samson had been frustrated by the limited performance of his aircraft and the feeble bomb loads carried, deciding that such pin pricks were useless. If the aeroplane was to inflict any real damage on the enemy it had to be big enough and powerful enough to carry and deliver a substantial load of bombs. The First Lord of the Admiralty W.S. Churchill also agreed with this aggressive stance and supported the idea. During an admiralty conference held on April 3rd 1915 (just two months after the basic design of the prototype HP had been agreed upon) the minutes of the conference state... 'The First Lord pointed out the necessity of developing a very large fleet of aircraft capable of delivering a sustained series of 'smashing blows' on the enemy; more in the nature of 'bombardment' by ships than the present isolated 'dashing exploits' of individuals or two or three aeroplanes dropping a few bombs only.'

It is doubtful if even Churchill could foresee how this suggestion could develop into a doctrine 30 years later. The

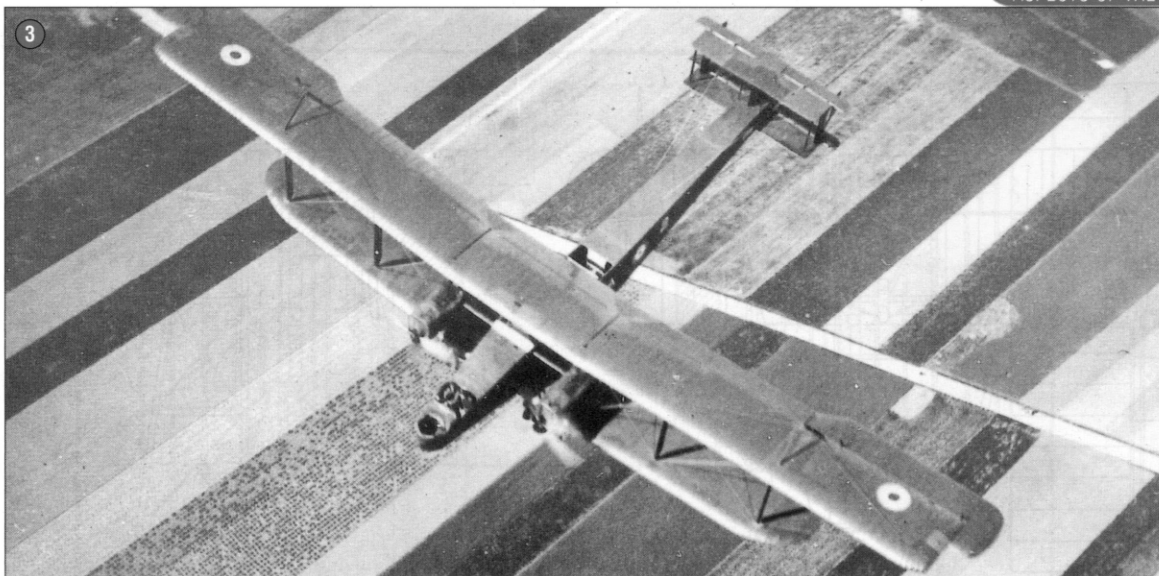


origins and development of the HP O/100 and O/400 have been described several times and it is not the purpose of this kind of feature to merely rehash history. The writer hopes that this kind of article can offer some insights and added detail of use to modellers. The emphasis on armament is one area which is often neglected by authors and this is addressed in the Aspects series. Advice on kits where applicable and especially reference sources are listed.

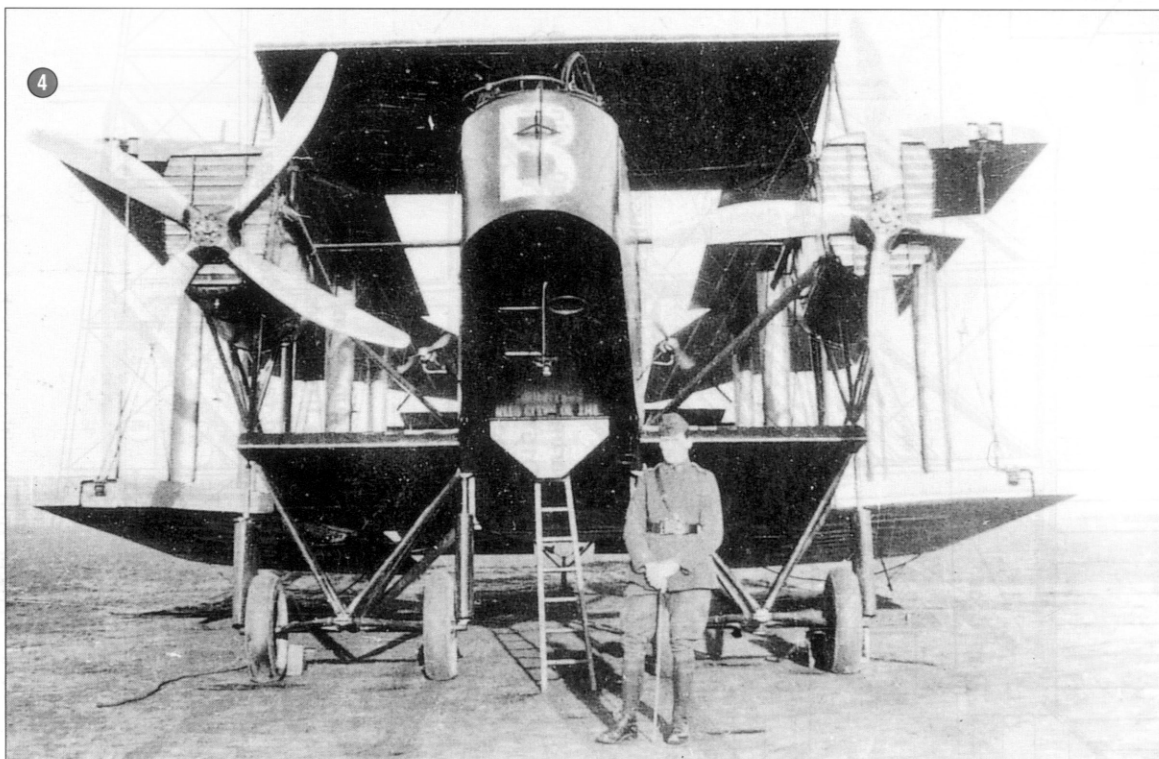
When pursuing old material, especially inter-war magazines and books, one almost gets the impression that the HP was the main heavy bomber of WWI although the Gotha gets a mention. It is well to place the Handley Page in its true perspective in military aviation history. The first successful war mission completed by a Russian Il'ya Muromets type Veh took place in February 1915 when Ship VII on a reconnaissance mission also dropped 578lb of bombs. In August 1915 the first sortie of the Italian Caproni three-engined bomber was carried out. German twin-engined aircraft commenced operations originally as escorts to single-engined bombers and soon as bombers in the autumn of 1915 whilst the first mission by a German Giant (the Staaken VGO.II) took place on the Eastern front in August 1916. It was

P1: With its original RAF serial painted large, an interim step before full civil registration was applied, this Handley Page - built O/400 was the third aeroplane to receive a Certificate of Airworthiness on May 1st 1919. Named 'Vulture' it opened the London/Paris service on September 2nd 1919. Subsequently registered G-EAAF she was scrapped in August 1920. Note the long range fuel tank on top of the fuselage

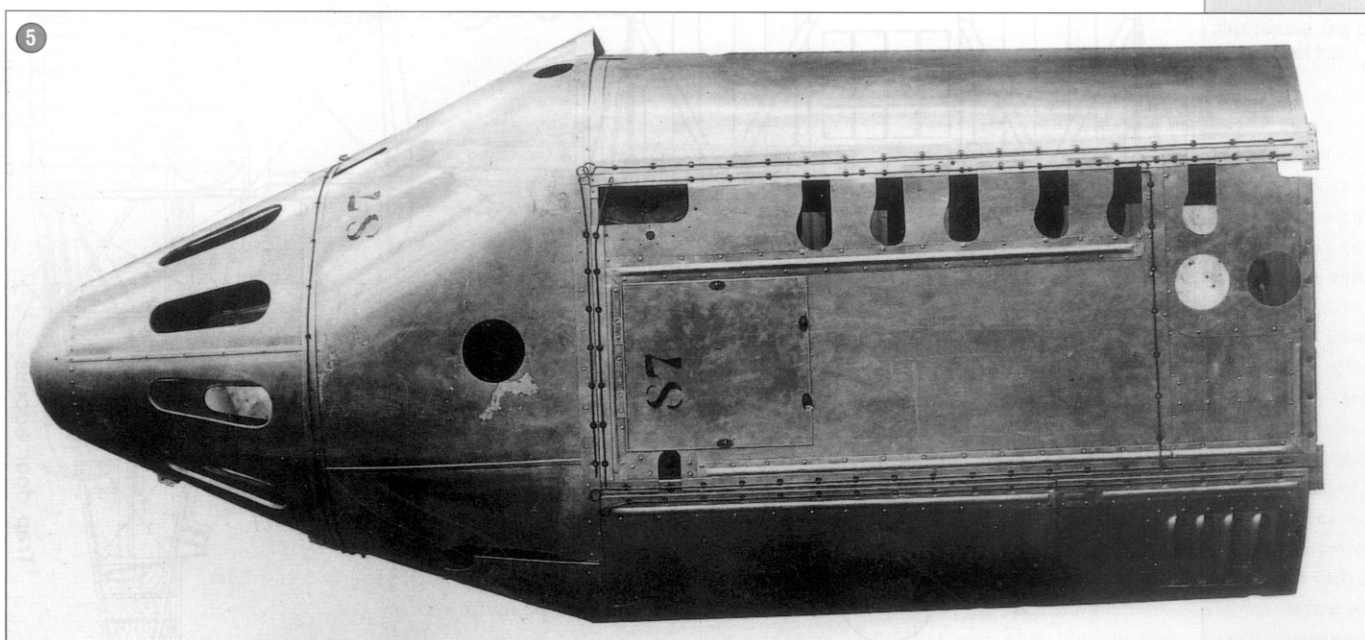
P2: HP O/400 serial D.9702 built by Clayton and Shuttleworth of Lincoln. Note the small cockade and the typical later style of rudder marking



P3: HP O/400 'A.2' of No. 207 Squadron RAF flying over Germany in May 1919. This machine, serial B.8811, was built at the Royal Aircraft Factory at Farnborough



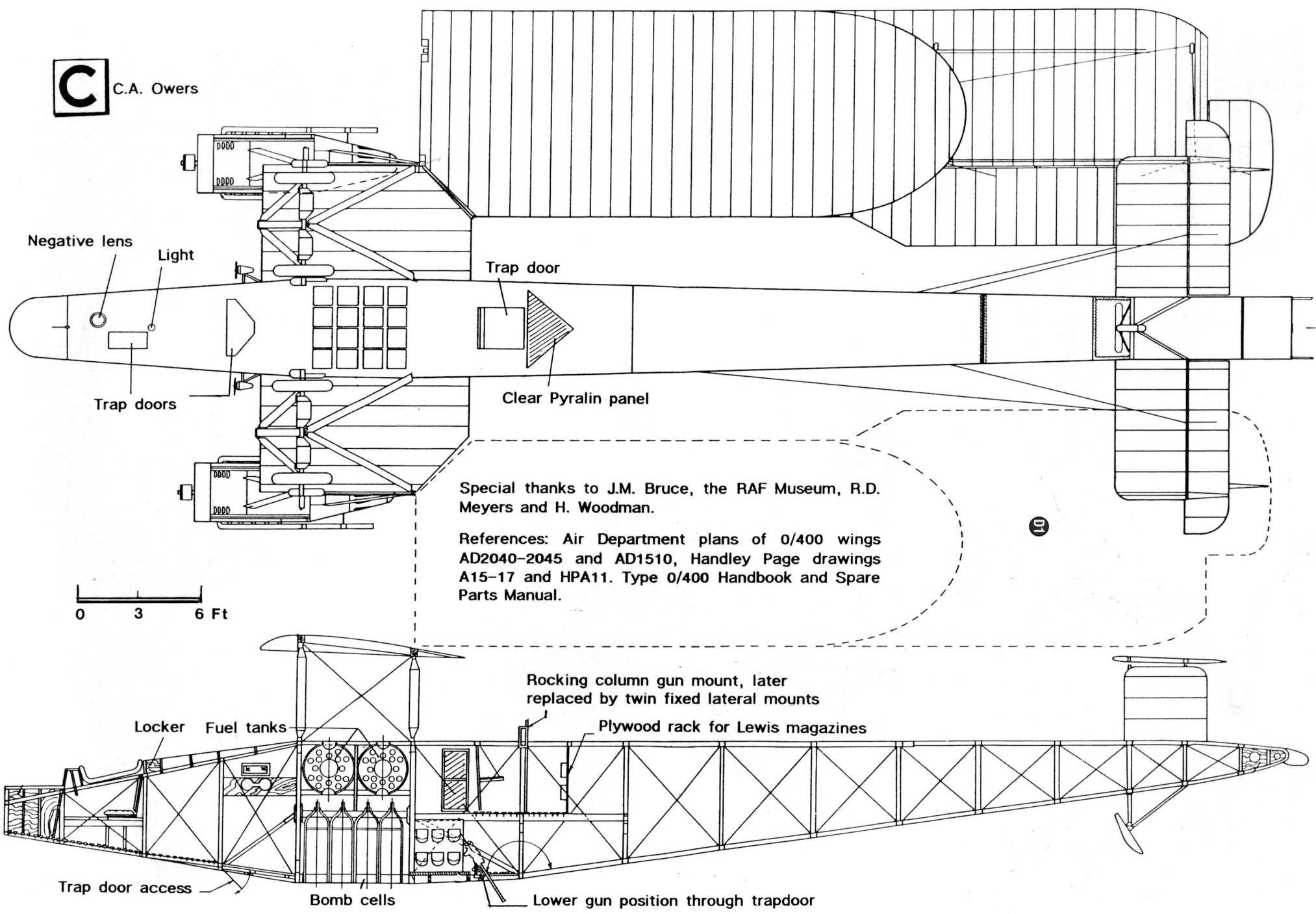
P4: A useful photo of a HP O/400 nose with wings folded; note the jury struts seen just outboard of the engines, essential items when this action was taken. The undernose trapdoor access with the 'Keep clear of the propellers' warning, the two wind driven fuel pump generators and the frame of the circular negative lens sight are also apparent



P5: The port nacelle of the O/400 inner face. The outlet holes for the exhaust are obvious but the circular holes accepted the oil pressure and rev counter gauges. This arrangement was not particularly liked by the crew who had to peer with hand torches from the cockpit to read them

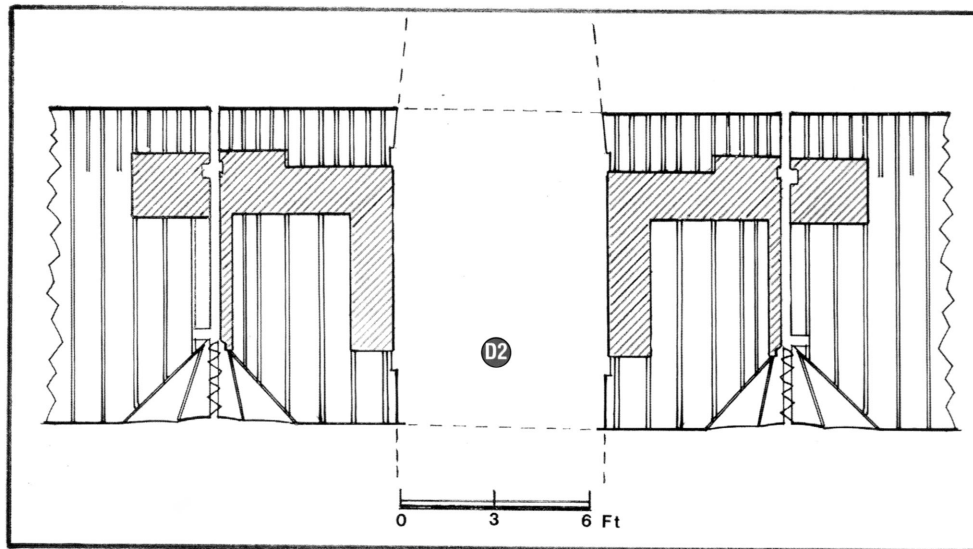
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C.A. Owers



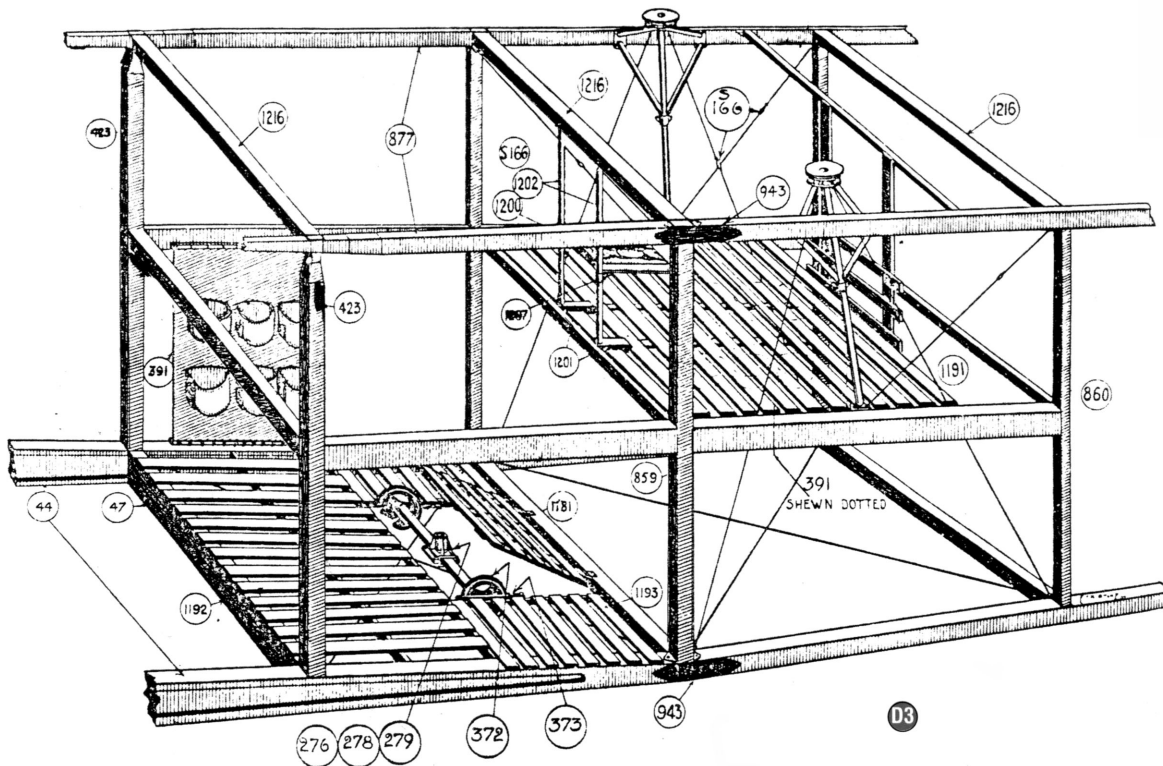
Special thanks to J.M. Bruce, the RAF Museum, R.D. Meyers and H. Woodman.

References: Air Department plans of O/400 wings AD2040-2045 and AD1510, Handley Page drawings A15-17 and HPA11. Type O/400 Handbook and Spare Parts Manual.

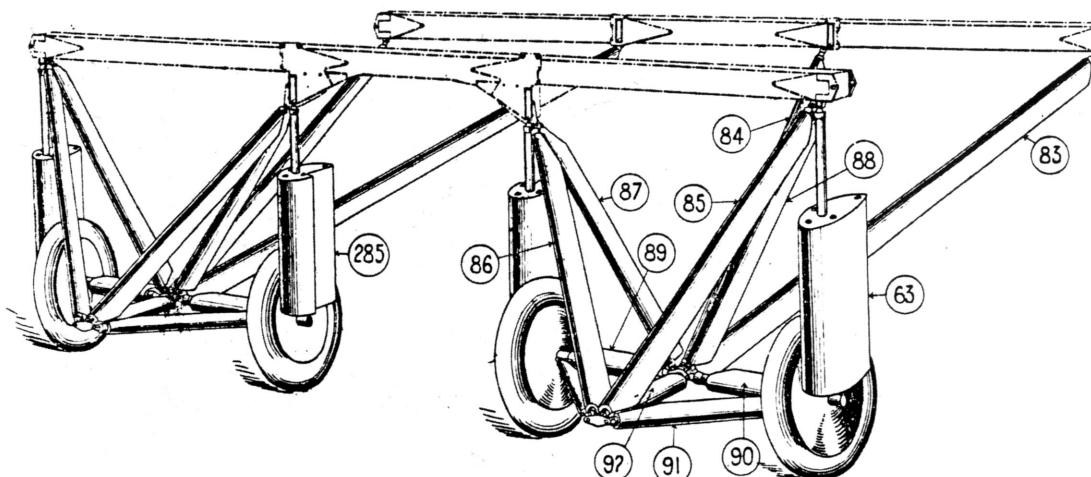


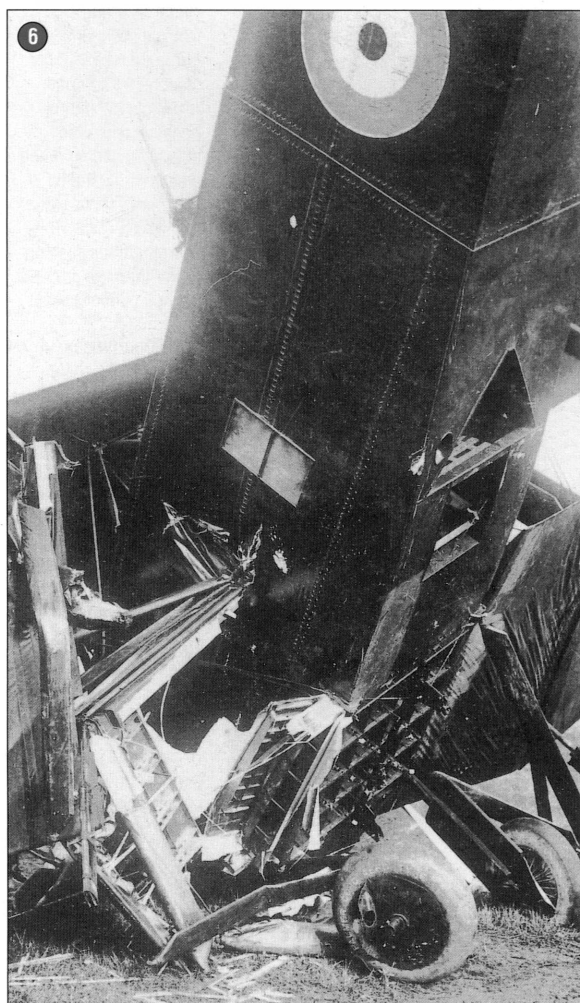
D.1: (Opposite Page) Underview and internal structure, compare with sketches. The small rectangle behind the negative lens was actually a sliding hatch which was used by the bomb-aimer when the sighting was done from the floor position rather than the nose cockpit (Colin Owers)

D.2: Copied from an original HP drawing this shows the areas of the lower wing sections covered for engine maintenance. The areas were covered in plywood faced with thin aluminium sheet and overpainted. The upper wing areas were the same without the footwalks



D.3: Reproduced from the official catalogue of parts the upper sketch shows the central fuselage area with the two fixed lateral gun mounts (Bowen-Williams pattern). This gun position was placed two feet further back than the single rocking pillar mount (see drawing and photo.) Note the pockets for Lewis magazines and the lower gun position and trapdoor. The lower sketch of the undercarriage units illustrates a peculiarity, the inner faces of the inner pair of shock absorbing units are partly cut away with to prevent bomb tails from striking them after release. One can assume that this happened





not until March 1917 that the first raid was carried out by a HP 0/100. The Germans subsequently developed a whole range of twin-engined bombers from the production lines of Gotha, AEG and Friedrichshaven, apart from the huge R-planes.

Handley Page production was limited although several factories in addition to the parent firm were manufacturing the bomber by the end of the war, as well as from a host of subsidiary firms providing components. The original impetus came from the RNAS for a long-range night bomber and when in 1917 there arose an outcry over German bombing on the British mainland a (largely political) decision was taken to create what was effectively a strategic bomber force to attack Germany. The Army were never really keen on this; their idea of airpower was that it should be tied totally to co-operation with the Army in the field. What happened was the employment of the 'day bomber' which formed the bulk of the so-called 'Independent Air Force'.

The two-seat single-engined day bomber hardly fulfilled the purpose of delivering a 'smashing blow' to the enemy, the D.H.4-9 series carried only a quarter of the bomb load of a Handley Page and was caught in what we would now call a Catch 22 situation. To fly a long distance to a target needed extra fuel which meant reducing the bomb load and vice versa. Of course more heavies were in the pipeline such as the Vickers Vimy but there were many losses in a campaign which did not inflict as much damage as was fondly believed at the time.

The single-engined day bomber remained a standard item in the RAF inventory for many years reaching its apogee or perhaps more accurately its nadir in the Fairey Battle in 1940.

By the time that the HP 0/400 appeared in late 1917 and excellent Rolls-Royce Eagles became available, many improvements had been made since the prototype 0/100 had flown on December 17th 1915, and techniques and advances in

armament and bombing techniques were developed. The 'observer' was responsible for several tasks in flight and usually acted as a bomb aimer (or bombardier to our American friends). The original position had been on the floor behind the pilot with the sight being fixed to the floor and sighting done through a sliding panel. The aimer instructed the pilot on course changes by pressing various buttons which lit up small bulbs in front of the pilot. This was disliked by many and eventually the aimer was positioned in the nose or 'forward gun pit' as the RNAS insisted on calling it. The High Altitude Drift sight touched up with luminous paint was employed mainly for night bombing and the aimer guided his pilot with hand signals. Bombs were carried internally in racks suspended by the nose; the common load was sixteen 112lb bombs but other combinations could be accommodated. Really heavy stuff such as the Naval 550lb bombs had to be suspended on special carriers externally as did the RAF's first 'blockbuster', the 1650lb SN bomb. This was a rather crude thin-walled missile designed for maximum blast effect and had to be suspended under the fuselage on a special Gladhill slip like a torpedo.

An 0/100 was used to test a form of night camouflage (a somewhat optimistic endeavour) but the standard colour scheme for all HPs was simply an overall PC.10 khaki-drab (try mixing chrome yellow and black).

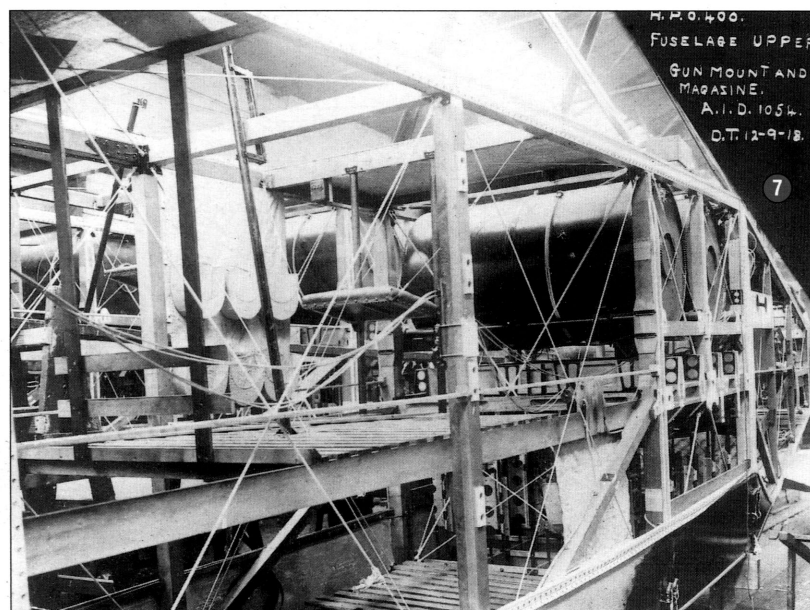
By 1918 large roundels had given way to much smaller ones on 0/400s and eventually the white area was darkened. The final roundel was created by extending the red centre outwards to meet a thickened blue ring which totally eliminated the white. Large white stripes and handling marks were painted on the rear fuselage which also displayed the serial in white. The original Airfix box art has several errors including an 0/400 finished in dark green 'Nivo' which did not become standard until post-war.

The Airfix Reissue

The original kit was issued at the end of 1968 when Airfix was at the height of its success as a leading manufacturer of plastic kits. The balloon burst in 1981 when the firm called in the receivers owing £15 million. Younger readers may not appreciate just how successful and influential Airfix was during the great decades of the 1960-70s. A selection of the old kits are currently being reissued with new box art but it seems little else, but the writer can only comment from hearsay. Some of the old Airfix kits can still stand alongside their modern equivalents, others can not. In recent years there has been a great upsurge in kits of WWI aircraft in several scales; most recent have been the excellent

P6: This HP crashed in German territory. The photo shows in detail the underside of the machine: the bomb apertures, the square gun hatch and the triangular clear Cellon or Pyralin covered panel are all seen to advantage

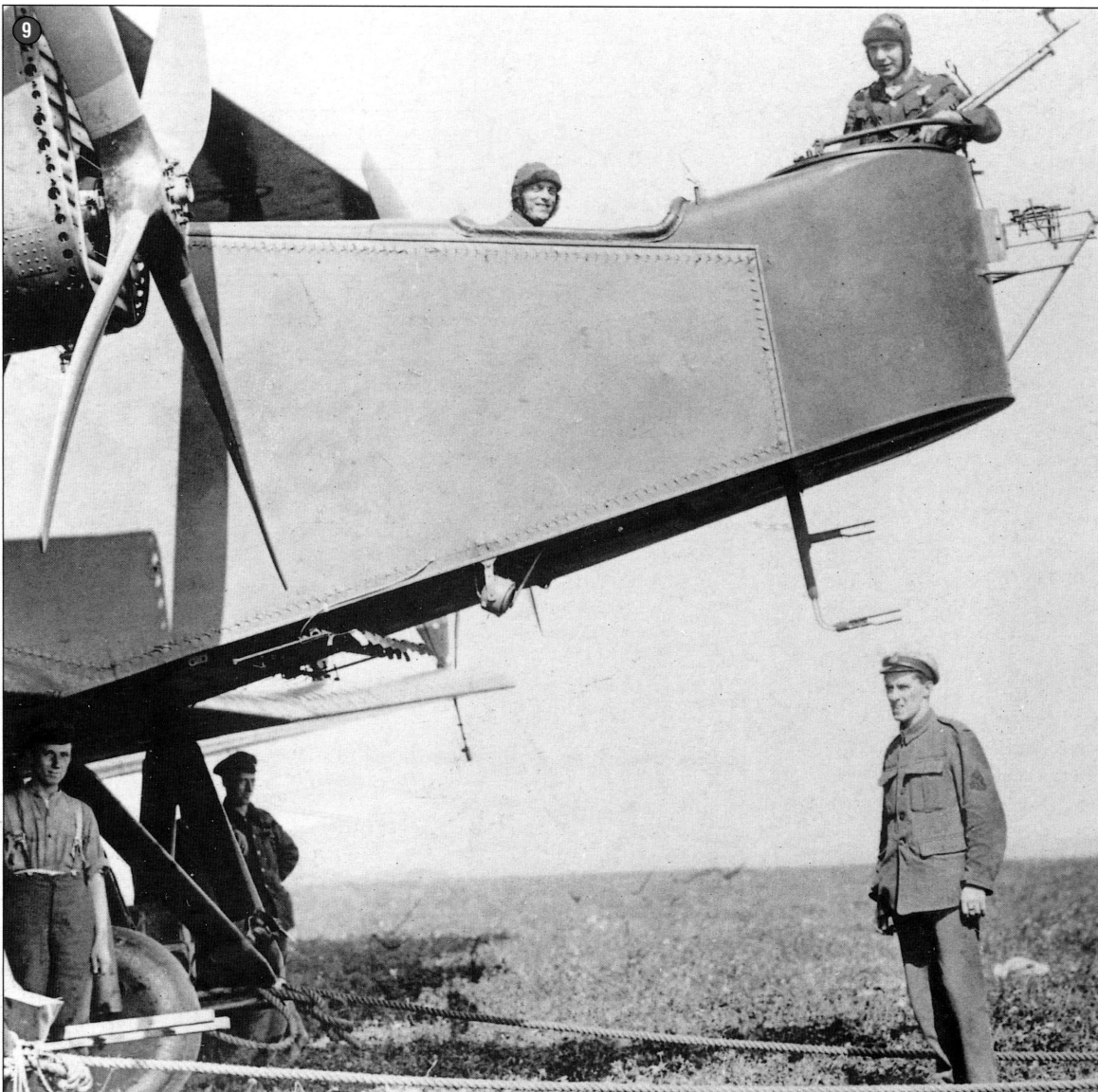
P7: A close-up of the uncovered interior of the aft fuselage under construction. The original rocking pillar mount for the rear upper single gun is clearly shown. Twin Lewis were fitted on fixed lateral mounts later (see sketch) but the pillar mount remained in use until the end. Note the Lewis magazine rack, folding seat and main fuel tanks

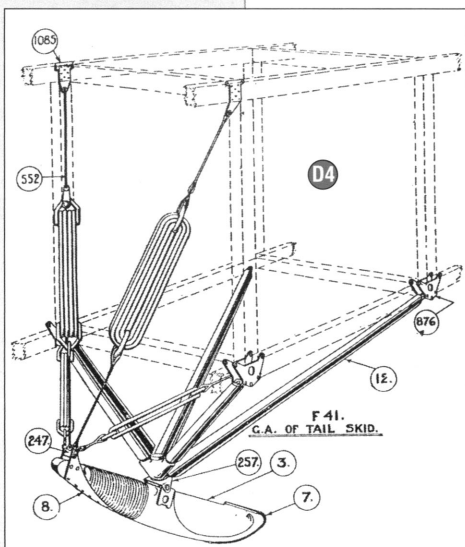




P8: This close-up reveals all manner of detail. The ample padding around the cockpit is clearly shown as are the two small Triplex glass folding windscreens. Compare the dash with the sketch. The Observer/bomb aimer in the nose has a Mk. III Lewis which appeared late in the war fitted with a Hazelton muzzle booster, a 97-round No. 5 magazine, a ring rear sight and a Norman vane fore sight plus an improved Mk II collector bag for empty cartridge cases. The whole was mounted on a Scarff No. 2 gun ring

P9: More details of armament etc. are shown here. The original bomb-aimer's position was on the floor behind the pilot but most observers preferred the sight to be fitted to the nose for quicker communication with the pilot. The instrument is the standard HA (High Altitude) Drift sight. Under the far port wing can be seen a bracket for Holt incendiary flares (glorified fireworks offering good illumination to aid night landing but prone to going out at the wrong time.) Under the fuselage is an electric floodlight useful for signalling on a landing approach or to use when the aircraft was on the ground. Behind the lamp is a Light Series Carrier for four 25 pound Cooper bombs. Note the double ASI Pitot tube

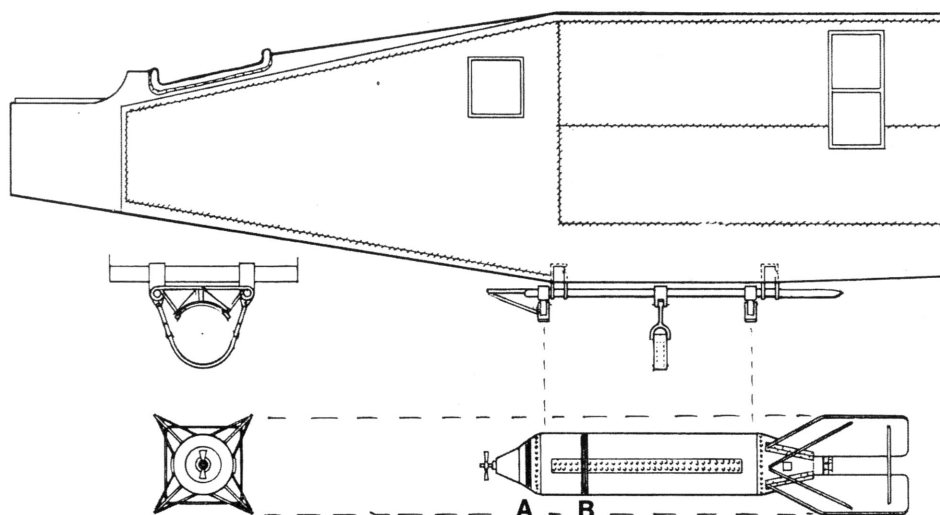
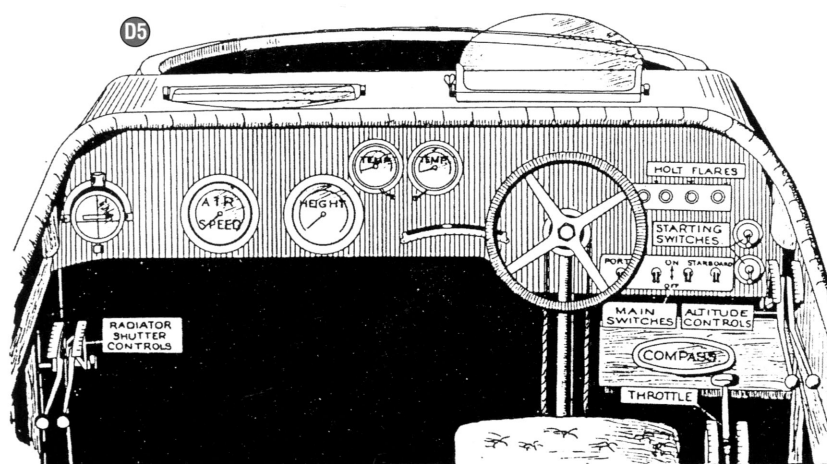




D.4: Constructional details of the massive tail skid which followed general practice of the time. Resistance was provided by belts of bungee rubber cord.

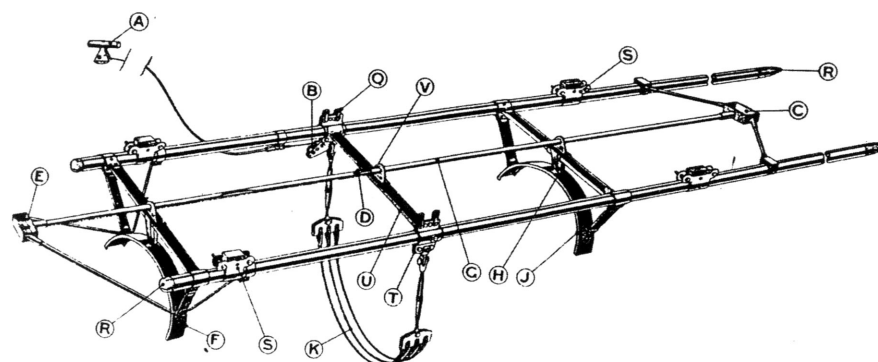
D.5: This layout of the pilot's dash as published in the RAF Flying Manual (AP 129, 1920). It shows the standard layout which seldom varied. The instruments seen (from the left) are a Type 5/17 compass, ASI altimeter, two thermometers (for radiators) and a curved clinometer underneath. At right are Holt flare switches, switches at right for starting magnetoes, main switches underneath and under them on the floor a main compass. At the pilot's side are the main throttles (one lever with swivelling head controlling both engines) whilst at extreme left are the radiator shuttle controls operated by the observer who sat by the pilot's side on a folding seat whilst in flight

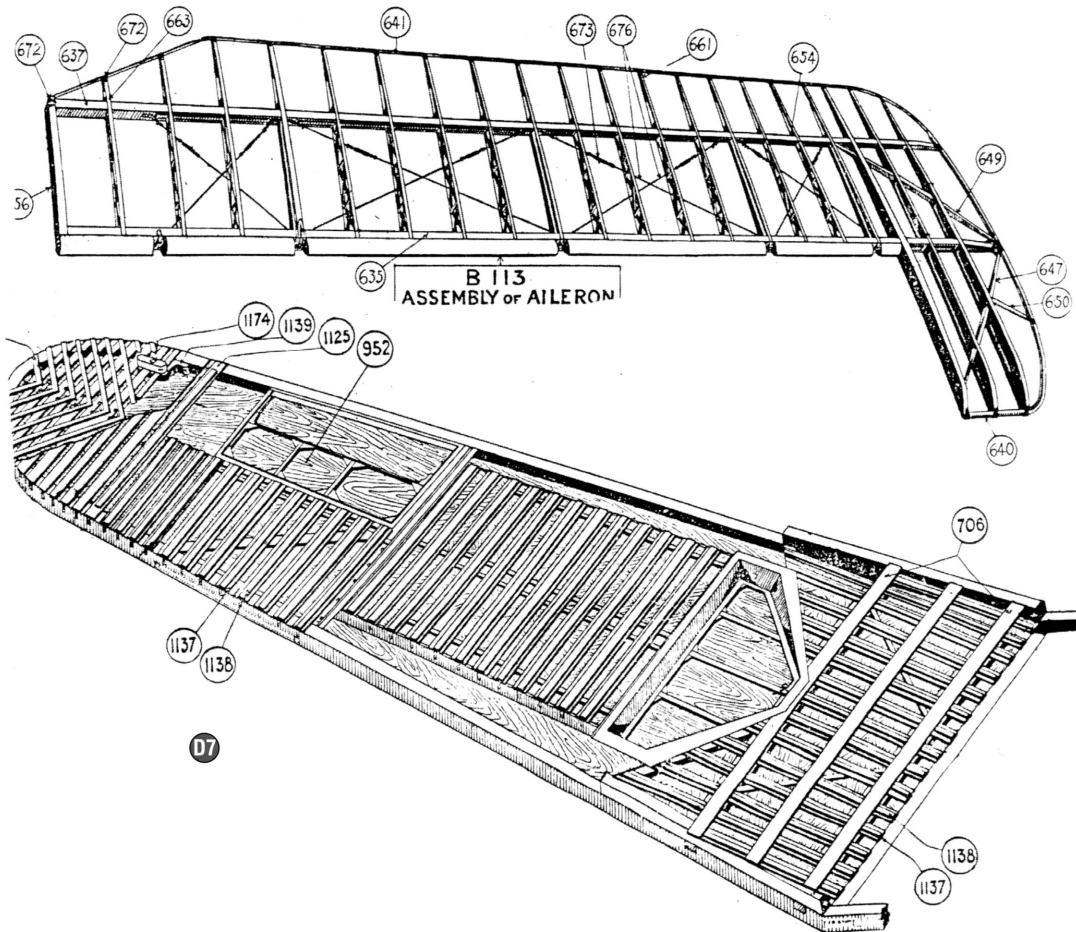
D.6: The big 1650lb 'SN' bomb became available in February 1918. The term 'SN' has usually been taken by some to mean 'Essen' but in fact the letter 'N' signified 'Naval' from 1916 at least. The RNAS developed a whole series of their own bombs and the suffix 'S' may have meant merely 'Special' as a code term. The bomb shown is the Mk 1 as used in the war and the drawing in 1:72 scale shows the actual size and form. The bomb was painted in the standard colour for HE bombs, an overall dull buff. Nose and body stripes indicated filling, in the sketch the nose band A was red whilst the band B was green. The 'Carrier for Bomb SN Mk.1a' in the sketch below was identical to the original Mk 1 except that the rear of the main tubular members were extended to accommodate the later larger 3300 SN 'Major' bomb which was never carried. Note the bomb release toggle at 'A' and the triple steel cable sling



D.6

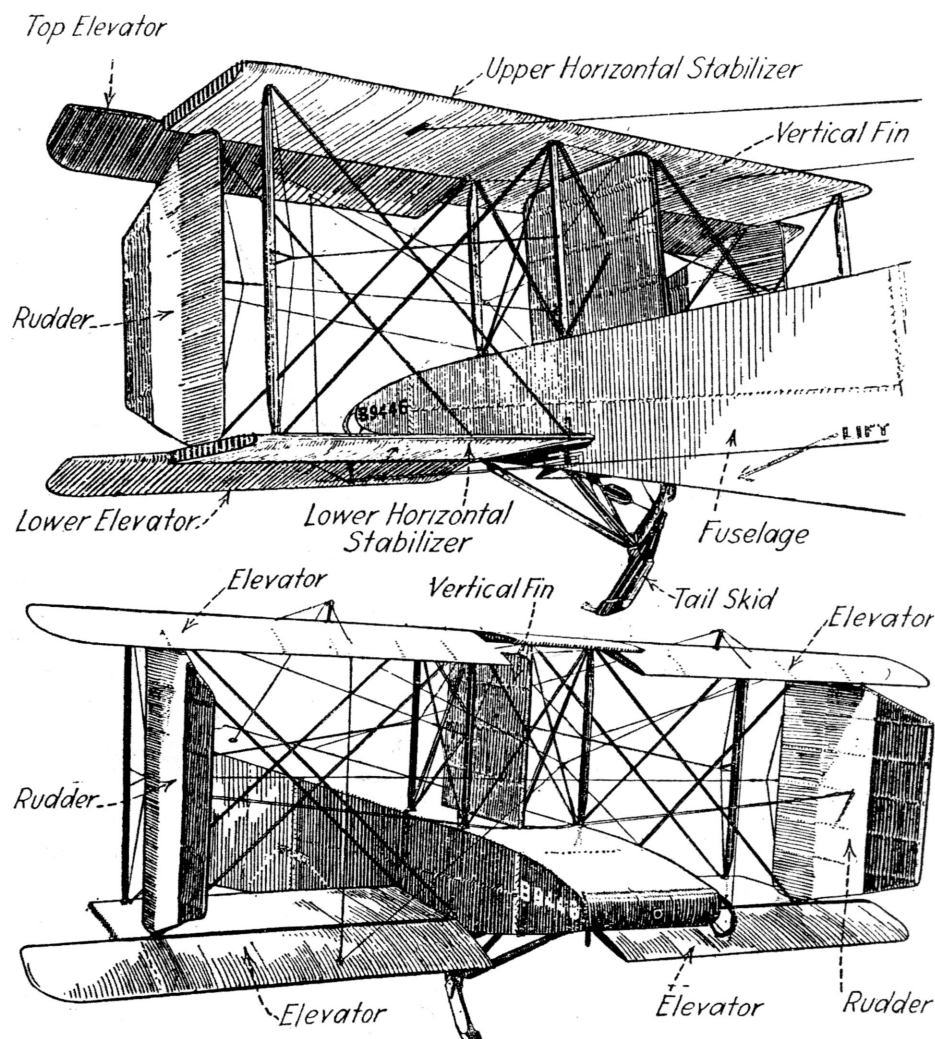
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D.7: Sketches of the aileron construction and floor of the forepart of the fuselage. The latter shows the crew access trapdoor and various panel areas forward. In this sketch no space has been allocated for the negative lens sight although the sliding panel used when the bomb-aimer used the prone floor position is shown

D.8: The rigging of the tail was extensive to counteract the tendency to twist in banked turns. These two views help to unravel the complexity, the main rigging wires being deliberately emphasised here. The elevator control cables are notable in as much as elevators on both sides are connected by a cross-over of cables. The rudders were controlled by the horizontal cables, the motivating cables in front and the reciprocating cables fixed to the mid-rudder points



Gotha G.II - V kits in 1/72nd scale from Roden. Presumably the distributors of Airfix think that the time is right to disinter the old HP kit but this writer has some reservations.

He still has an original untouched kit and the following comments reflect what he said when he reviewed it in January 1969. The criticisms are still valid but it must be emphasised that they concern the original kit. It is not known if the flaws in the original have been corrected in the reissued kit which at the time of writing has yet to be seen, but frankly it is doubtful. When old kits are reissued generally the only changes that are made consist of new box art, possibly some slight cosmetic touches to surface detail and nice new decals. When the HP 0/400 kit first appeared as part of Airfix's regular Christmas new issue in 1968 the writer was asked by the editor of a magazine to review it.

The advance publicity raised hopes that were soon dashed when the kit was examined and the writer's review reflected this disappointment. It should be noted that what follows describes the original kit, however, as suggested above it is doubtful if any changes have been made to the reissue. A great deal of care had been taken with some smaller detailed parts of the kit, the faults lay with major items. It has always been the writer's maxim that any kit in which errors can be corrected without throwing away major components is a good kit, and this is still true today. In the case of the HP kit the entire wing assembly and parts of the tail are so badly represented that extensive and tiring remedial work would be required. Dismissing other errors, some minor but irritating, it is necessary to concentrate on the wings and tail surfaces. One wonders what references were used by Airfix when the master was being created. At the time two 1/72nd scale drawings were available, a very old one in the 'Aeromodeller Plans Service' from the 1946/7 period and that appearing in the Harleyford 'Bombers of WWI' published in 1962. It seems that many still have copies of this volume which is fair but variable. This drawing although basic was not too bad and had Airfix used this as a guide then their kit might have been redeemable. In addition, there were several people around at the time who could have provided accurate and detailed research material had Airfix bothered to ask. For those still in the dark, the wings of 0/400 were formed in the usual way with main spars and full ribs with nose riblets between the main members which were apparent only on the upper surface. The lower surfaces of such wings were either flat or slightly concave, the only external detail being the rib taping.

On the Airfix kit the upper surfaces are covered with thin plank-like extrusions bearing no resemblance to wing ribs. If reproduced full size they would represent 'rib tapes' six inches wide and 1 1/2 inches thick! Not only that but no nose riblets are represented and the characteristic fan-shaped fabric webs at the trailing edge where the wings folded are absent. The undersurfaces are also rather silly, with fine raised lines instead of flat taped areas. The tail assembly also suffers from this nonsense.

A great deal of small fiddly detail is included in the kit, some of it is superfluous as it is totally concealed when the kit is assembled, indeed, the whole design rationale of the model is puzzling, it is as if two different master model makers were involved. In the writer's original review he suggested ways of correcting the wing surfaces which involved sanding both surfaces flat. Rib and riblets could be reproduced by applying very thin plastic tape (available then for graph work). Another method used by the writer in other cases was to apply a 'skin' of thin plastic card. The wing sections are drawn on 10 thou card, the rib locations being scored. The skin is then stuck to the sanded-down upper surfaces which is the difficult part as normal cement does not allow adjustment and may warp the thin plastic. Some readers may be surprised to learn that clear varnish can be



used; it takes longer to dry but sticks well. These days many adhesives are available; what is required is one that will stick plastic to plastic without softening it.

Perhaps some enterprising firm will reproduce replacement wings (the tail assembly is much easier). The undersurface needs really nothing although rib tapes can be represented by scoring with a sharp point. The original review when published was not universally appreciated; apart from Airfix, there was and possibly still is a group that believes that unfavourable reviews, even when fully justified, should not be published.

This writer disagrees; on the rare occasions on which he is asked to review a kit or a publication, the principle adopted is that the reviewer owes his allegiance to the potential modeller or reader rather than to the manufacturer or publisher.

References

There is no Datafile on the HP 0/400 (yet!). Older references include C.H. Barnes account in *Air Enthusiast* of August 1973 which includes a cut-away, not bad but not entirely helpful in some areas. Barne's excellent history of the company was published by Putnam in 1976 (since republished).

The drawing and brief account in the 1962 Harleyford has been mentioned but without doubt the most useful of all is Chaz Bowyer's *Handley Page Bombers of the First World War* published by Aston in 1992, and copies may still be available. The book is comprehensively illustrated and contains Colin Owers' drawings.

There may be other references of which the writer is unaware or has forgotten.

Statistics

The Handley Page 0/400 was built by many manufacturers including the Standard Aircraft Corporation of New Jersey, USA. During WWI as demand exceeded supply, many firms became engaged in aircraft production and it is not always apparent if these manufacturers and sub-contractors always built precisely to the original drawings provided by the parent company. Some variations are obvious, others not. In addition, GA drawings reproduced often stated overall dimensions. For those who liked to have some firm figures the following statistics are reproduced from the *Handley Page Biplane, Type 400, A.P. 363* published by the Ministry of Munitions in September 1918. *MAM*

P.10: A familiar photo but none shows the the 1650 pound S.N. bomb better. Laid out for the photographer in front of an 0/400 of No.207 Squadron at Ligescourt on August 29th 1918, the big bomb is displayed with two 25 pound Cooper bombs. See sketch for actual size, colour and method of slinging the bomb under the fuselage. Note the twin Lewis guns



1. The prototype Hawk 200 ZG200, which was lost in an accident, that claimed the life of its pilot Jim Hawkins.

Photographs courtesy of
BAe Systems via Andy Evans

'The Single Life'

THE BAE SYSTEMS HAWK 200

by Andy Evans

There have been many instances throughout aviation history where a single-seat aircraft has spawned a two-seat derivative, either for conversion training to type, or to add a tactical role to the aircraft's repertoire - thereby requiring a second crewman. It is a rare event then when a two-seat aircraft produces a true single-seat version with increased capabilities, yet retaining its original ancestry. Therefore disproving the old mathematical saying 'two into one won't go', comes the BAe Systems Hawk 200.

The idea of developing a single-seat variant of the Hawk first took root in the mid-1970's, when pilots, who having flown the Mk 1 Hawk, began to remark that the aircraft's handling characteristics were more like those of a front-line combat aircraft than an advanced trainer. The Hawk's rugged airframe, high subsonic speed, excellent maneuverability, long range and superb weapons carrying capabilities provided considerable operational potential - and one way to explore that potential was through a single-seat variant. The proposed single-seat version had in fact two stalled attempts to get past the drawing board stage. Finally in 1983 the then British Aerospace again examined the merits of funding a new 'lightweight' fighter for the expanding Asian and Middle Eastern markets. The aircraft would carry its own radar, self-defence suite and internal guns. The single-seat layout would provide excellent all round visibility, with the pilot being positioned in what would have been the central point of the two-seat cockpit under a bubble canopy, whilst at the same time leaving adequate space ahead of the cockpit for additional fuel. Space beneath the cockpit was initially utilised for two internal 30mm Aden guns, but early in the flight test program, these were deleted in favour of the proven centre-line gun pod, thereby freeing additional space for avionics equipment. The nosewheel leg was also moved slightly



more aft, in order to provide more space for mission equipment. Thus the first Hawk 200, ZG200 made its maiden flight from Dunsfold Aerodrome, in Surrey, England on the 19th May 1986, but was tragically lost in an accident, which claimed the life of its pilot Jim Hawkins. A second aircraft was constructed and ZH200 flew on April 24th 1987.

The Hawk 200 built on the advances gained with the Mk 63 and the Mk 100 series, and featured the more powerful updated Rolls Royce/Turbomeca Adour 871 twin-spool, low by-pass ratio turbofan engine, as well as extensive structural commonality with the Mk 100 aircraft, aft of the rear bulkhead. Flexible fuel tanks are installed in the fuselage together with compartmented integral tanks that are located in the wings. The aircraft also sports the seven-station 'combat wing' with combat

2. The second Hawk 200 ZH200 flew on April 24th 1987. Note the Harrier GR.7-like camouflage, the centreline recce pod and the absence of the tip-mounted missile rails



3. ZH200 in its desert scheme. Note the Skyflash and Sidewinder armament.

4. The second and most striking camouflage scheme applied to ZJ201.



5. ZJ201 the Radar Development aircraft takes to the air in its primer coat.

6. ZJ201 in its all-over grey garb. Note the 'No Step' markings.

7. The third of ZJ201's schemes, two-tone blue grey - very smart.





8. A Malaysian example at its home base. Note the F-5 in the background.



9. Looking like the world-beater that it is. The Hawk Mk 208. Note the low-intensity formation light strips beneath the missiles on the wings and under the cockpit.

maneuvering flaps, a tail-mounted radar warning receiver (RWR), and an automatic or manually fired chaff and flare dispenser fitted above the engine tail pipe. The aircraft also incorporates the small horizontal fins (or SMURF's) forward of the tailplanes designed to eliminate tailplane stall. The most striking aspect of the Hawk 200 is its redesigned nose that houses Northrop Grumman APG-66H multi-mode radar of the F-16 ilk, plus a Honeywell 764G Inertial Navigation System/Global Positioning System (INGPS), and an air data sensor, display processor and mission computer. The radar has ten air-to-air modes and four sub-modes for detection tracking of airborne targets, and a similar number of air-to-surface modes for the detection and tracking of land based and maritime targets. Routed through a MIL STD 1553B databus, the APG-66H can pick up fighter-sized targets in excess of 25nm, and large sea targets at ranges exceeding 60nm.

The 200 also features Hands On Throttle And Stick (HOTAS), a full colour Head Up Display (HUD), a 13-button heads down Multi Function Display (MFD) and comprehensive Weapons Control Panel (WCP). The MFD has a dedicated processor and 15-colour graphics symbology generator with 27 display formats that provide flight and aircraft data. The pilot can select the weapons and release mode prior to initiating an attack by using the Weapon Control Panel, which controls the Stores Management System. The pilot sits aboard his Martin Baker Mk10LH bang seat, operating hydraulically-powered flight controls, in an ergonomic modern office.

Offensively the aircraft can carry a range of NATO and US weaponry, as well as the ever comforting Sidewinder AAM's on wingtip and/or underwing pylons. Options include: rocket launchers, reconnaissance pod, retarded and freefall bombs up to 1000lb, runway cratering, anti-personnel and light anti-armour bombs and cluster bombs. On air defence missions, the Hawk 200 can sustain a two-hour patrol 100nm from base when fitted with underwing fuel tanks. In a close air support it has a radius of action of over 100nm, and for interdiction roles, the

'200' can deliver 2,000lb of ordnance at a range of nearly 300nm. Range can be extended by use of a fixed 'bolt-on' in-flight refuelling probe. Britain hit the 'breakthrough button' with the Harrier, and now the Hawk, in all its guises, has seen another breakthrough, becoming one of the most important and prolific aircraft in the world.

Hawk 200 Statistics

Length: 37ft 3in
Wing span: 32ft 7in
Height: 13ft 1in
Load Factor: +8 to -4g
Max speed at sea level: 550kt
Engine: Up-rated Rolls-Royce/Turbomeca Adour 871 Turbofan

Hawk 200 Operators & Colours British Aerospace/BAe Systems Hawk 200 Demonstrators ZG200

This first prototype was initially painted medium grey topside with light grey undersides at a line just above the gun ports to just below the jet pipe. The aircraft carried a light grey 'Hawk 200' logo outlined in black on the forward fuselage, a black radome and stylised gold-coloured Hawk motif on the tail. Just prior to the aircraft being lost it received an all-over semi-gloss black finish, losing its nose logo but retaining the Hawk on the tailfin.

ZH200

The second prototype sported a 'double green' scheme in a similar hue to the 'original' Harrier GR.7, with the darker upper surface colour wrapping around the lighter underside of the wings. Again no logos were carried, but the Hawk motif on the tail was now light grey with black details. The aircraft was later painted in a wrap-around disruptive Dark Sand and Stone scheme for a sales tour of the Middle East. The markings featured pale pink and pale blue roundels and fin flash, and the

10. A superb plan view of the Hawk 200. Note the weathering created by the vortex generators on the wings, and also note the 'Smurf' below the tailplane.

11. Oman was the launch customer for the Hawk 200, and here we see an example being readied for return to its HAS. Note the Ram Air Turbine just in front of the tail.

12. Oman purchased the Hawk 203 to replace its Hawker Hunters.

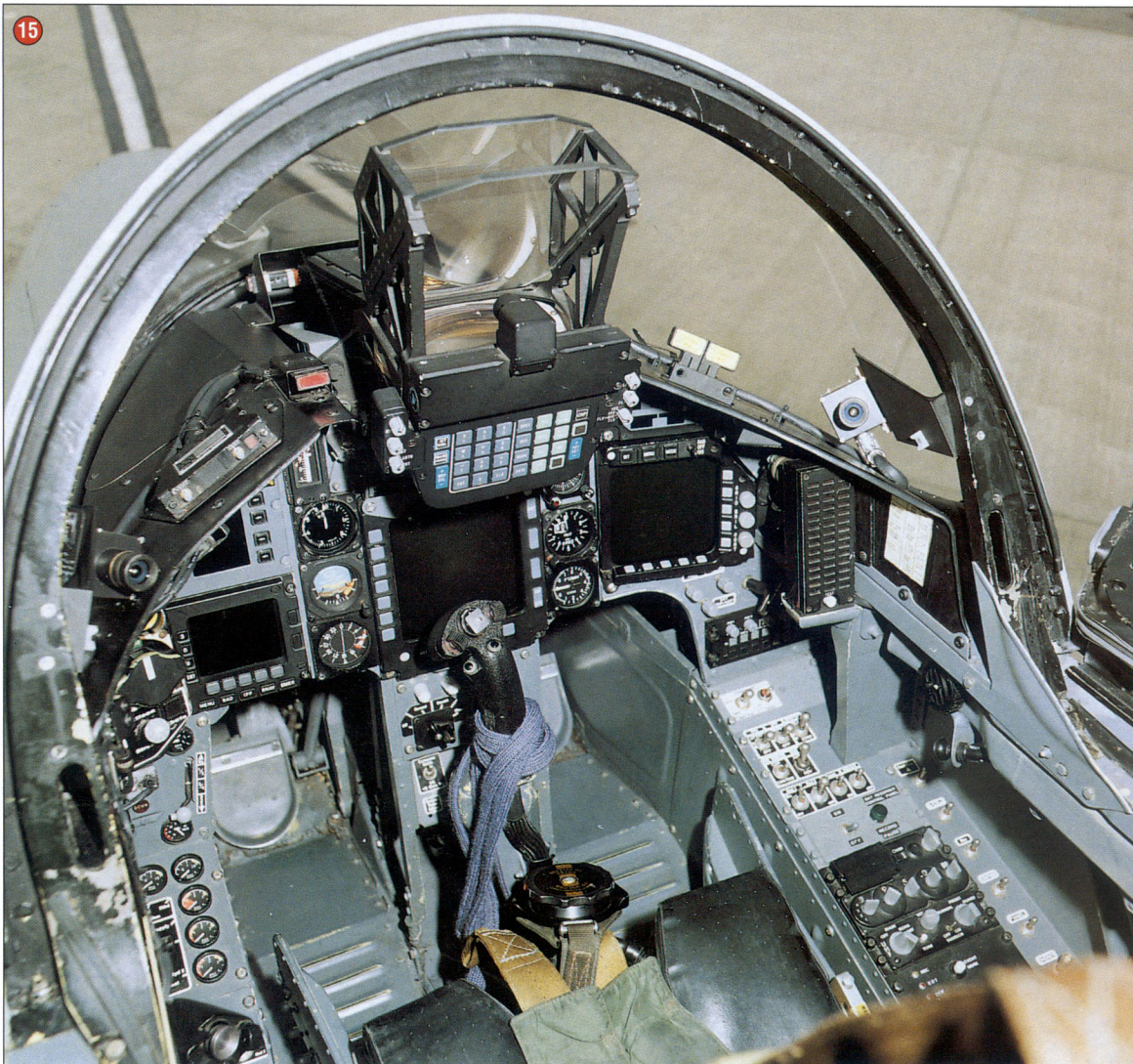




13. Indonesia ordered the Mk 209, painted in a medium green and light brown disruptive scheme.

14. An Indonesian Mk 209 comes into land at BAe Systems Warton after a test flight.

15. The cockpit of ZJ201, the Radar Development Aircraft





16. Refuelling a Hawk Mk 208 - Single Pressure Refuelling Point

logo 'British Aerospace Hawk 200' in black on the forward fuselage sides, and 'Hawk ZH200' either side of the rear fuselage roundel. The grey Hawk again adorned the tail.

ZJ201 (RDA)

ZJ201 was the Radar Development Aircraft, which first took to the air on the 13th February 1992, and as the name suggests did much to mature the aircraft's systems. ZJ201 first flew in its Yellow Chromate primer colour with a grey radome and two black diagonal stripes on the forward fuselage with 'Hawk 200' across them. ZJ201 wore three distinctive camouflage schemes. Firstly all-over air defence grey was used, then on top of this black was applied to the wings over the engine intakes following their contours down the rear fuselage, completed with a black anti-glare panel on the nose and black flashes on the forward fuselage. Two red chevrons were also applied to the wings. Later the aircraft was painted in a very smart pale blue and pale grey disruptive wrap around scheme with low-vis roundels and fin flash. ZJ201 was lost in an accident in Bratislava in 1999.

Oman

Oman was the launch customer for the Hawk 200, ordering 12 Mk 203s to replace its Hunters in 1990. Deliveries were completed in 1995.

Omani Camouflage & Markings

Oman chose an all-over medium 'air defence grey' for their aircraft, with little in the way of markings save an Arabic script and small ID number on the rear fuselage and a blue shield tail badge.

Indonesia

The Indonesian Air Force ordered 16 Hawk Mk 209s in 1993

Indonesian Camouflage & Markings

Indonesia chose medium green and light brown disruptive colours which were applied to the upper surfaces, and a light grey applied to the lower surfaces, with the radome being of a light blue/grey hue. National insignia were applied to the wings and rear fuselage, together with a red and white tail flash. ID codes are carried on the tail, the last two digits being repeated on the nose.

Malaysia

In December 1989 the RMAF placed orders for 10 two-seat Hawk Mk 108s and 18 Hawk Mk 208s. Deliveries began in 1994 and were completed in 1995. These Hawks have a fixed IFR probe and nosewheel steering. The Malaysian aircraft also feature low-intensity formation light strips on their forward and rear fuselages and on panels beneath the wingtip AAM launch rails

Malaysian Camouflage & Markings

Like the Omani Mk 203s the Malaysian Mk 208s are painted in an overall medium grey scheme with a light grey radome. A small Malaysian national insignia is applied to the intakes with a blue, black and yellow tail flash with a small two-digit ID number on the nose. On the wings the national insignia is found above the left and below the right wing tip, completed by 'TUDM' lettering on the opposite sides. The 'TDUM' is repeated on the rear fuselage sides. The tailfin also has a colourful unit badge applied to it, and the aircraft also have a prominent white arrow on the engine intakes with a red 'Danger' motif applied to it. Also of note is the copious number of red 'No Step' markings on the wings, tailplanes and SMURF's. [MAM](#)

Acknowledgments

Sincere thanks are due to Gordon Bartley at BAe Systems Hawk Sales Team at Warton for his invaluable assistance in the preparation of this feature.



Jaguar GR.1A certainly proved its worth with Operation Granby

Gulf Mission Markings

by Graham Napper

The first opportunity for the public to study allied aircraft involved in the Gulf War came at RAF Mildenhall's Air Fete '91, where a good cross-section of types was presented. Sticking out like proverbial sore thumbs were the desert pink RAF aircraft, emblazoned with colourful nose art and detailed mission markings; less obvious were the symbols carried by American veterans of Operations Desert Shield and Desert Storm.

Supporting the US effort in deploying transports, bombers, fighters and recce aircraft were the tankers, represented at Mildenhall by KC-10A 87-0124, from the 344th Air Refuelling Squadron, 68th ARW, normally based at Seymour-Johnson AFB in North Carolina. On the port (left) side of the nose was its normal 'Spirit of Kitty Hawk' emblem (featuring Wright brothers, their Flyer and the KC-10), but on the starboard (right) side, between flight deck window and crew entry door were six barely discernible crossed sword markings, effected in black on dark green camouflage.

Standing off from the ground war were several

intelligence gatherers, among them Lockheed TR-1A 80-1081, from the 95th Reconnaissance Squadron, 17th RW, based at RAF Alconbury. Two drawings had been chalked onto the fin, that to port showing a camel and palm trees with the stars and stripes flowing in the wake of a TR-1, that to starboard having a pair of crossed Saudi swords over a dragon (presumably a reference to the TR-1's 'Dragon Lady' nickname) and palm tree, with a TR-1 flying above. Red mission markings behind the starboard canopy area showed 13 missiles (Scud hunting?) and two ships encircled and crossed through in 'Ghostbuster' style.

Intelligence gained from such aircraft enabled accurate bomb runs from B-52G 58-0193 'Iron Maiden' and 59-2568 (unnamed), both of the 668th Bomber Squadron, 416th BW, Griffis AFB, New York State and both carried markings showing thirteen bombs and one camel, under the rearmost flight deck window. At lower altitude flew the faster strike aircraft and Wild Weasel radar hunter-killer teams of F-4G and F-16C. Mildenhall presented F-16C 86-0287 from the 480th Tactical Fighter Squadron, 52nd TFW, Spangdahlem, Germany, wearing thirty-six dark-grey stencilled mission

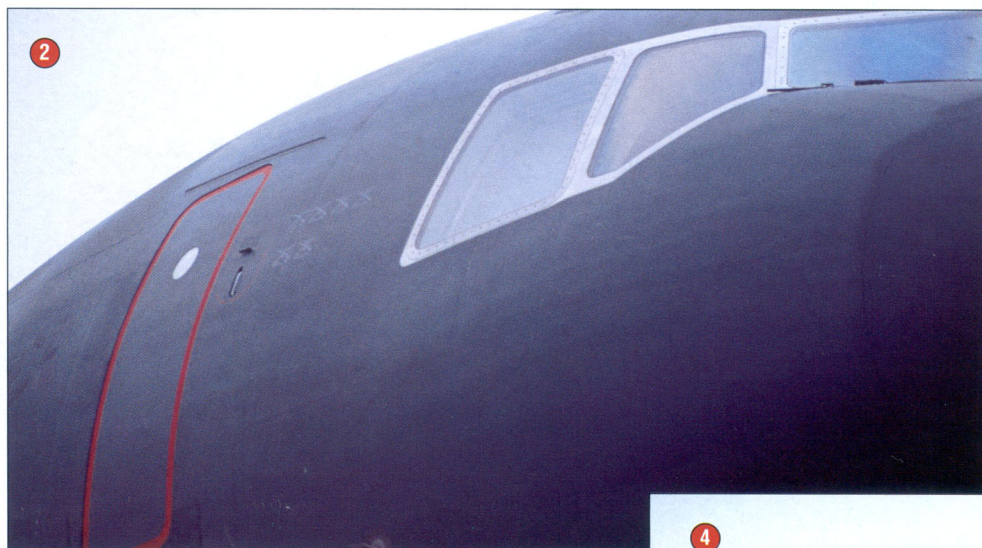


1 'Spirit of Kitty Hawk' proves that bright markings are possible on this KC-10A

2 Look very carefully for the low-key mission markings

3 Dragon Lady in the desert

4 The temporary nature of chalk is evident with the deterioration of this drawing





Sword and shield-bearing Iron Maiden rides a polar bear, next to the Gulf War mission markings

markings to illustrate its intensive Gulf operations. To provide the raiding jets with safe passage into enemy territory, EF-111s were used to jam enemy electronic emissions. EF-111A 66-0055, from the 42nd Electronic Combat Squadron, 66th ECW, RAF Upper Heyford, carried four yellow lightning flashes as proof. Of all these US aircraft, only the TR-1 had artwork applicable to the Gulf, all camouflage being standard, with no concession for use over desert.

'Scudbuster' - not to mention two ships

For the British, an indication of tanker utilisation could be gained from Victor K.2, XM717, from No.55 Squadron, which had ninety-two petrol pump symbols painted below a 75th anniversary emblem (No.55 Squadron formed on 27th April 1916). The bulk of RAF air raids came by Tornado GR.1. 'MiG Eater', ZA447, carries shark's teeth and eyes, with a complete shark (obviously of the basking variety, laid back with fins behind head) swallowing a MiG-29. This MiG features in the mission markings ahead of three JP233 runway cratering munition symbols, twenty-three free-fall iron bombs and fourteen Paveway laser-guided bombs, each one representing a successful air raid.

Paveway bombs were guided to their targets by Pave Spike designator pods carried by Buccaneers, such as XV352, named 'Tamdhu', an S.2B of No.208 Squadron ('The Jolly Rogers'). Under the starboard windscreen are eight Paveway bomb markings in black, plus two in red. No.54 Squadron Jaguar GR.1A, XZ367, wears an elegant white rose and fully detailed mission markings showing that seventeen sorties were flown with a weapon load of four 1,000lb iron bombs, one sortie carrying two 1,000lb bombs (other pylons would have been taken up by ECM and chaff/flare pods), and twenty-two sorties were made four CBU-87 Rockeye cluster bombs on each attack. Apart from providing an aura of excitement to the aircraft and a means of standing out from the crowd, these markings demonstrate the high workload achieved during the war. **MAM**





7 This F-16C, killer half of a Wild Weasel team, has obviously been busy

8 A modest tribute to active service on an Upper Heyford-based EF-111A

9 Gulf veterans all: Tornado GR.1 from Laarbruch; VC-10 & Victor K.2 from Brize Norton; Jaguar GR.1A from Coltishall; KC-10A from North Carolina



10 'Lucky Lou', a windswept lady in tattered dress, holds a spear plucked from the squadron badge

11 Laarbruch-based No.15 Squadron has the apt motto 'Aim Sure'

12 No.208 Squadron's naval association (formed as No 8 Royal Naval Air Squadron) provides the 'Jolly Roger' name applied on the other side of the nose





(© RAAF via Glenn Sands)

RAAF Mirages

by Glenn Sands

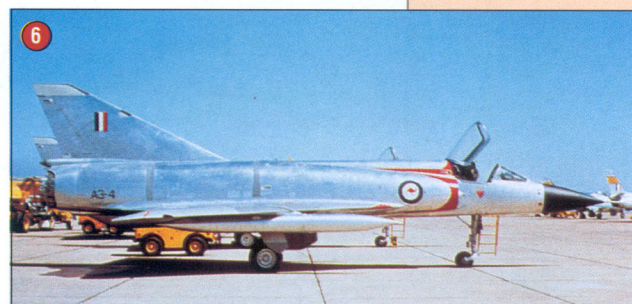
The Australian Defence Forces hold a unique position, not only geographically but, in the requirements and operational roles of its air force. The Royal Australian Air Force (RAAF) is the second oldest in the world and emerged from World War Two with a highly regarded reputation and distinguished combat record, from operations not only within Europe but the south-west Pacific theatre; many senior officers were keen to keep this reputation intact. Immediately after the war a rapid up-grade programme was implemented, with a host of war-weary aircraft being withdrawn and orders placed not only for foreign aircraft, but the establishment of building such types under licence as part of the Commonwealth Aircraft Corporation (CAC), at a later date. This was a practice that had greatly expanded during the war years to produce such types as Beaufighters, P-51 Mustangs and Mosquitoes.

As with many post-war air forces, the RAAF had already introduced its first jet fighter into service, the de Havilland Vampire, and although its performance was an improvement over other piston-engined aircraft, at the time a later generation of jet fighter was deemed necessary. This came by way of the North American F-86 Sabre. Constructed under a licence agreement which saw the replacement of the Sabre's General Electric J47 turbojet with a more powerful Rolls-Royce Avon, this change in powerplant resulted in a substantial redesign of the Sabre's fuselage as the Avon needed more air, requiring a larger intake and, being lighter and shorter than its American equivalent

needed to be moved aft in order to retain the Sabre's centre of gravity. The Avon Sabre was regarded as the best F-86 Sabre day fighter variant, although at the cost of a substantial redesign, and first flew in August 1953, and was followed by a production run of 111 aircraft under the CAC designation CA-27 commencing in August 1954.

However, despite giving sterling service throughout the Fifties the need for a supersonic fighter to equip squadrons within the RAAF was apparent almost as soon the F-86 entered operational service. Preliminary studies were undertaken with a joint evaluation team from the Departments of Air and Supply who visited Europe and North America in 1960. Early investigations centred around the Lockheed F-104 Starfighter, Northrop F-5 Freedom Fighter, McDonnell Douglas F-4 Phantom II and the English Electric Lightning, with the F-104 emerging as the firm favourite and an order placed for thirty examples by mid-1957. But, soon after the order was announced it was cancelled and the Starfighter rejected. In its place, an additional order was placed for extra Avon-powered Sabres, the reason being that the F-104 was too specialised, too expensive at A\$2m per copy, and was of 'questionable use for ground support duties.' Following this the search for a Sabre replacement was cancelled at great cost - within a year the search was back on!

By late 1959, the Starfighter had emerged once more as the leader in the search, with additional types now including the T-38 Talon and an up-graded F-5 Freedom Fighter. What saw the



1. A3-2 releases its load of Mk 82 Snakeeye retarded bombs from its 'AMSER' Australian Multiple Stores Ejector Rack. Also fitted are wing-tip photo pods
(© RAAF via Glenn Sands)

2. At low level on a test flight is ARDU's A3-2, inverted and bombed up!
(© RAAF via Glenn Sands)

3. ARDU's Mirages were used for a variety of weapons tests and trials, many of them involving the clearance of weapons for other aircraft within the RAAF inventory
(© RAAF via Glenn Sands)

4. A view of A3-112 of ARDU in the 'Fanta Can' colour scheme. This was the final colour scheme for ARDU's Mirage fleet
(© RAAF via Glenn Sands)

5. One of the first Mirages built for the RAAF, A3-2, ended its days with the RAAF Edinburgh based Aircraft Research and Development Unit (ARDU). A3-2 is seen here flying with a Royal Australian Navy (RAN) Macchi shortly before the fixed-wing component of the RAN was dismantled

6. Pictured on the ramp at RAAF Williamtown in September 1964, is A3-4. This particular aircraft had only been delivered seven months prior, and was lost at Avalon in August 1972 following engine failure

7. Wearing the colours of No. 75 Squadron is this Mirage IIIO(F). This was typical of the early schemes that the aircraft operated in, which were similar to the early French schemes, with red scalloping around the intakes. Later, a fleet-wide camouflage would be introduced



8. Seen on an untypical wet day in Australia is this Mirage IIID in the bright colours of No.2 OCU. This aircraft is finished in Aluminium Lacquer scheme and carries the early 'sunburst' style fin markings



9. Upon entering service with ARDU, A3-2 initially wore a Golden Yellow and Brunswick Green colour scheme. The modified fuel tanks can be seen in this view and were used to carry telemetry and photographic equipment instead of fuel



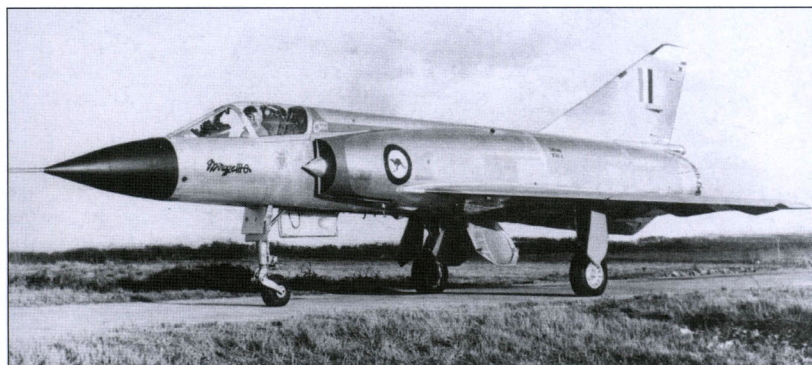
10. During the 1980s an interim scheme was introduced to the ARDU Mirage fleet and is seen on A3-76. This aircraft crashed in May 1984, off the coast of Adelaide



11. A3-112 wears the final 'Fanta Can' scheme due to its similarity with the popular soft-drinks can. Despite their age ARDU's Mirages were kept in immaculate condition throughout their long service



12. Seen at RAAF Butterworth in August 1984, is Wing Commander Sexton's Mirage IIID of No.75 Squadron. These colours are typical of many Mirages during the period, although there were exceptions



Starfighter now back in contention was the development of the F-104G model, which in addition to the interceptor role, was now capable of undertaking light ground-attack missions in its multi-role guise. Leading the field once more it was assumed that the deal had all but been completed and on this occasion, it was just a case of signing the papers and the F-104 would soon be in RAAF colours.

With the race now all but over to find the RAAF's first supersonic fighter the late French entry by Dassault with their Mirage III was regarded by some as too little, too late. However, Dassault's Deputy Export manager, Bernard Waquet, a former Fleet Air Arm pilot had other ideas, and is regarded as the man responsible for selling the Mirage to Australia.

As the decision was drawing ever nearer, a flurry of overseas visits to both the United States and France during the 1960s to study the Starfighter and Mirage III took place and these saw, on December 15th 1960, the announcement that the Mirage would be the RAAF's new fighter. For the second time in little over three years the Starfighter had lost out in Australia.

In retrospect the F-104G Starfighter variant that was being offered to the RAAF was just as capable as the Mirage III, but outspoken criticism of the former was great, in particular by the Governor of New South Wales, Sir James Rowland, who had been involved in the selection process and who, as a Wing Commander, was the test pilot with the technical mission under Group Captain R T Susans which went to France in 1961 after the Mirage had been chosen!

Australia's first order, signed on March 31st, 1961, was for thirty single-seat examples, but was later increased to sixty in October 1962, and one hundred in May 1963. In October 1963, an order was placed for ten dual-seat Mirage IIIDs and was later followed by an additional contract for six more in November 1970.

The initial decision was greeted by the Minister for Defence, Mr Townley, who said that the airframe and engine of the new aircraft would be manufactured to a substantial extent in Australia, and that the thirty aircraft would be sufficient to re-equip one squadron and an Operational Conversion Unit (OCU). Also that deliveries were expected to begin in 1963. Mr Townley was questioned about the compatibility of the French Mirage with Australia's prime ally in the region, the United States, and he pointed out that the Mirage would carry the necessary equipment to operate with USAF aircraft in the same operational environment. Mr Osborne, Minister of Air, also announced his reasons given for selecting the Mirage: "Among modern high flying aircraft with a performance of Mach 2.0 or better, the Mirage is characterised by the simplicity of its delta wing and its ease of manoeuvrability and control. Our test pilots and the Chief of Air Staff, Air Marshall Sir Frederick Scherger, who have flown it, have all been most enthusiastic about the 'sweetness' of its flying characteristics and describe it as an aircraft which takes off, lands and can be manoeuvred in the air with ease and assurance, surprising in view of its high performance.

"The Mirage has been chosen after the most meticulous consideration of all aircraft available. Technical data of the fighters of the free world has been kept up to date by the Air Staff. They reduced the field to five, which were considered on the spot earlier this year by a team of highly qualified technical and operational experts from the Departments of Air and Supply, led by the Chief of Air Staff. The preference for the Mirage has been marked and unanimous.

"The Mirage was designed too for a NATO power and will therefore carry weapons, communications and electronic devices enabling it to operate in the same communication and control environment as United States and NATO forces. It has tyres of low pressure (135psi at maximum weight compared with 310psi for the F-104G and even lower at typical weights) which enable it to operate from airfields of less than the highest runway standards. This is of obvious importance to the RAAF with our special obligations in South-East Asia and the limited number of high-class airfields in the north of our own country."

With the final selection of the new fighter made, it was now a case of which variant of the Mirage III would the RAAF be equipped with. Mr Townley's statements indicated that the fighter would be fitted with a French engine or a new Rolls-Royce powerplant. The British engineers sensed a commercial opportunity and in co-operation with Dassault converted one of the pre-production Mirage IIAs to take an Avon RB.146 Mk 67 fitted with afterburner. This was the same Avon version that was developed for the English Electric Lightning and promised not only greater thrust than the standard Atar 9 but also lower fuel consumption. The Avon-Mirage was designated the Mirage IIIO by Dassault and named 'City of Hobart' and made its first flight on February 13th, 1961.

Despite the impressive results, SNECMA, the French engine company, were keen to keep their own Atar engine in the Australian Mirage. During this time Australian pilots who came to France to evaluate the (Avon) Mirage were suitably impressed by the extra thrust and lower fuel consumption of an aircraft that had been modified for their benefit. But they were reluctant to replace the Atar engine in the Mirage as the British Avon powerplant had already a history of surging problems when the guns were fired and, had resulted in a number of losses among the Sabre squadrons. With each retrospective fault cancelling the other out, the decision tipped in favour of SNECMA if for no other reason than that the French powerplant would eliminate any engineering installation problems and would reduce the overall cost of the aircraft.

With the engine for the Mirage IIIO decided, the next decision to be made was, which type of Atar would be installed in the RAAF's fighter. Two versions were on offer, the standard Atar 9C or the more powerful Atar 9K which, at the time, was being developed for the Mirage IV bomber. The decision was made to retain the Atar 9C, as the Atar 9K was merely a 'paper engine' at the time and waiting for performance figures on this would delay the introduction of the Mirage into RAAF service considerably, then being planned for mid-1963.

By early 1961, major contracts had been placed with Australian companies who were to be involved with the production of the Mirage, the prime contractor being the Government Aircraft Factory (GAF) who were responsible for the final assembly and manufacture of the fuselage and CAC taking over construction of the wings, fin, rudder, tail cone and Atar engine. CAC allocated its company designation CAC-29 to the Mirage. Such was the allocation of work between the two companies, one Government owned, GAF, the other, CAC, a private company, who had thought that with their expertise they would get a greater percentage of the contract. Such was their utter dismay when their expectations were not met that a joint

enquiry was launched regarding what many believed was a deliberate snub to CAC. Rumours abounded that it was an attempt to put CAC out of business. It was left to the acting Australian Prime Minister at the time, John McEwen, to issue a letter in March 1961, that it was decided not to depart from the original decision, that GAF would be the prime contractor, but he did allocate the manufacture of the Mirage's wings and fin to CAC, who subsequently accepted this proposal.

This was not to be the end of the problems prior to construction of Mirages within Australia, as there were the difficulties associated with the language difference between Australian and French and the fact that all Dassault's manuals were in metric, whereas CAC and GAF worked in Imperial units. This proved to be a minor problem compared with what was to come. Australia's Mirage IIIO was based on a European variant that hadn't even flown itself by this stage, the Mirage IIIE.

Compared to the IIIE the IIIO had over one hundred and seventy-eight design changes to be incorporated, although many proved to be simplified. Such an example was the relocation of the radar scope in the cockpit, new landing light indicators and the installation of a radioactive dust filter near the instrument panel. The SEPR rocket booster was not specified for the IIIO and its vacant space was utilised as an additional fuel tank.

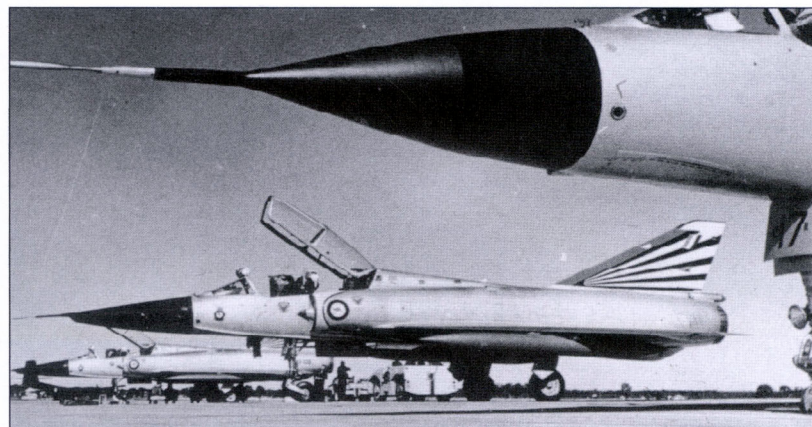
The armament for the IIIO was to be standard specification, with the utilisation of the DEFA gun pack with twin 30mm cannon. This was complemented by the AIM-9B Sidewinder, as had been fitted to the Sabre previously. An alternative to the Sidewinder for RAAF Mirages was the Matra R.530, but despite having the option to carry two sorts of AAM, in retrospect neither were capable of being launched in a tight-turning dogfight. In particular the R.530 came in for heavy criticism from pilots on a number of points. The first was that the AIM-9B was by now an elderly missile, and limited to 'six o'clock shots', the Matra which was intended to be an improvement was itself limited to hitting high-flying bombers going in a straight line, close-in, and in a dogfight the Matra was next to useless. Many years later the RAAF Mirages would be armed with the Matra R.550 Magic missile, an AAM which was comparable to late-model dogfight-capable AIM-9s.

For strike missions the Mirage IIIO would be armed with Mk.82 500lb (226kg) or Mk.83 1,000lb (454kg) bombs, SNEB rockets held in a 19 round launcher, or the AS.30 guided ASM. In the event that a deployment was necessary or a standing air patrol, external fuel tanks would be fitted with a total capacity of 1,034 Imp Gal, (4,700 litres), so affording the Mirages a ferry distance of 2,400 miles (3,862km).

The first two Australian Mirage IIIOs were manufactured completely in France with the first example, A3-1 taking flight on March 14th, 1963. Within weeks the aircraft was formally handed over to the RAAF at a ceremony at Villeroche Airport on the outskirts of Paris. After numerous ground tests A3-1 was loaded aboard an RAAF C-130A Hercules, A97-206, and was flown to Avalon airfield on January 11th, 1964. Despite the significance of this aircraft, A3-1 was to have an all too brief career, when on December 7th, 1964 it was lost during spinning trials while assigned to the Aircraft Research and Development Unit (ARDU).

The second Mirage A3-2 was to remain in France for some time after its first flight undergoing handling tests and didn't arrive in Australia until August 1965. It was immediately allocated to ARDU as a replacement for A3-1, with whom it remained until retirement in 1988. The aircraft was later one of a number that were sold to Pakistan in November 1990.

The first Australian-assembled Mirage, A3-3, took to the air on November 16th, 1963, although this was after a three-day delay due to poor weather and an electrical problem with the aircraft's



undercarriage. Pilot for this flight was Squadron Leader Bill Collings, who flew the aircraft for 50 minutes, reaching a maximum speed of Mach 1.5 at a height of 40,000ft (12192m). A3-3 was to remain in squadron service for over 23 years.

The second Australian-assembled Mirage was A3-4, and it was present with A3-1 at Avalon on January 29th for the ceremony, when the Minister of Supply, Mr A Fairhall delivered the logbooks of each aircraft to the Minister for Air, Mr D E Fairbairn.

The remaining Mirage A3-3 to A3-8 were supplied to the GAF and CAC in the form of major components which simply required assembly; later examples A3-9 and A3-10 were supplied as sub-assemblies while A3-11 to A3-15 contained ever-reducing components from Dassault. A3-16 is regarded by many as the first 'true' Australian built Mirage, which made its first flight in May 1965. However, there were to be a few exceptions in later Mirage deliveries. By this stage Mirage production was around 1.5 per month, increasing to two in 1966, three in 1967, and decreasing in 1968, as production of the first one hundred and ten examples drew to a close. Each Mirage was built to the major sub-assemblies stage at their respective facilities at Fisherman's Bend, Melbourne and then was transported by road to Avalon airfield, where final assembly and flight testing took place.

Although continual problems existed with the French assembly manuals, and the change from metric to imperial measurements during construction, Australian assembly of Mirages had relatively few problems; those that did occur were a lack of skilled workers during the early days and a series of industrial strikes at GAF which set back delivery dates significantly. In order to make up some lost time, ten complete and fitted-out Mirage IIIO fuselages were imported from France in 1966. They were A3-61, A3-63, A3-65, A3-67, A3-69, A3-71, A3-73, A3-77 and A3-79.

Despite the delays in production, the rate of aircraft leaving Avalon during assembly steadily increased. Early examples were spending six to eight weeks on the production line before being flight tested, where prior to this they would spend another eight weeks undergoing final checks. By 1967, each Mirage was taking even more time; an example of this is A3-68 which arrived at Avalon on February 16th, 1967 and was delivered for flight testing six months later on August 17th! It made its first flight three months later and was finally delivered to the RAAF in the same month, some nine months from arrival at Avalon to delivery.

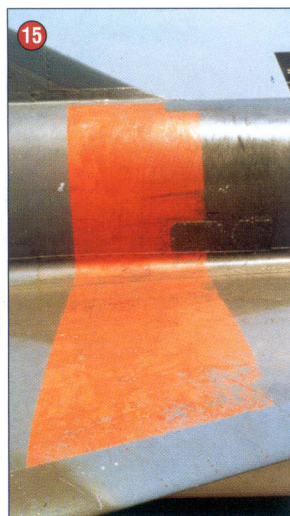
The RAAF operated two distinct variants of the Mirage IIIO, the IIIO(F) and the IIIO(A). The only exception to the following was A3-26. The first 50 aircraft were IIIO(F) interceptor models; missile and gun equipped operating in conjunction with a nose-mounted Cyrano IIA fire control radar, but lacking the Marconi-Doppler navigation attack equipment of the Mirage IIIE. The final Mirage IIIO(F) built was A3-50, which made its first flight



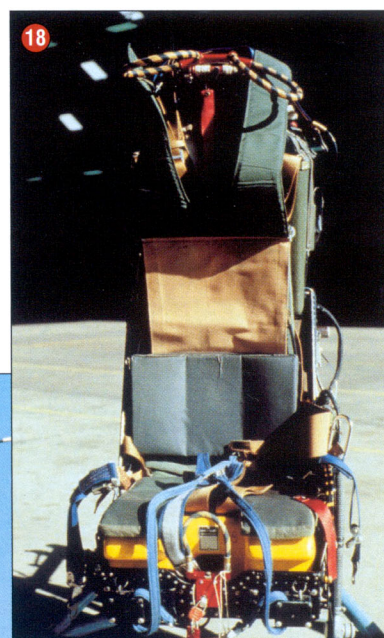
13. For the 60th Anniversary Air Show at RAAF Amberley in 1981, No.77 Squadron repainted several aircraft in this striking colour scheme; the aircraft were devoid of serials and wore the scheme for only a short period of time



14. During ACM training, instructors very often use two-seaters, as the Mirage IIID is of less weight than its single-seat cousin and, with only one pilot in the trainer, the IIID has an exceptional turn rate with gives many an opposing student a hard time. Temporary exercise bands are seen on this Mirage, A3-105, belonging to N.2 OCU



15. A close-up view of the temporary exercise markings applied to No.2 OCU Mirages illustrates the rough temporary nature of the bands



16. Returning from a training intercept mission is A3-83 from No.3 Squadron. At the time the squadron was based at RAAF Butterworth



17. One of the experimental schemes tested by No.79 Squadron at RAAF Butterworth in 1987, was this dramatic example. A3-99 carries the standard Hornet colours of FS.25327 uppers and FS.26375 lower surfaces. The Mirage's delta outline is broken by an arrowhead across the mid-upper fuselage and wings made up of smaller Dark Green arrowhead on top of a larger Dark Sea Grey design. Note the gloss leading edges, but otherwise the Mirage had an overall matt tone



18. A close-up view showing the colour details of the Martin-Baker Mk4a fitted to all RAAF Mirages. Note that no two components are the same colour. Some careful brush work will be needed here on a model!

19. Illustrating the high-viz colours of No.79 Squadron's emblem. The squadron was to be the RAAF's last permanent presence in Malaysia. It was formed as only a temporary measure to cover the transition period of other units to the F/A-18 Hornet

All Photos © Glenn Sands unless otherwise noted

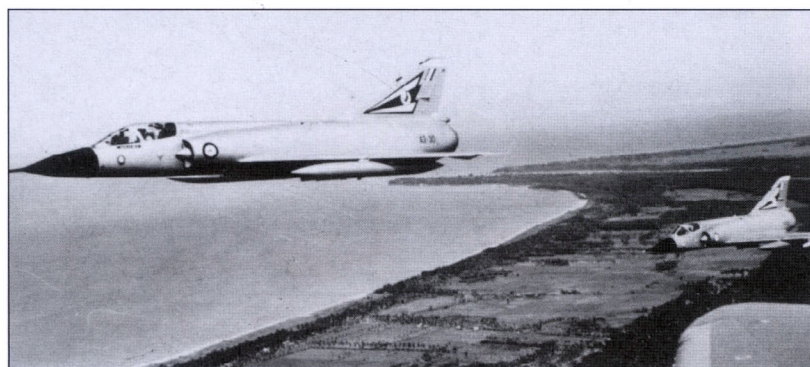
in May 1967, and was delivered for squadron service one month later. It is interesting to note that aircraft numbered A3-51 to A3-100 were manufactured from new as ground-attack/fighter Mirage IIIO(A)s with Cyano IIB, Doppler, a radar altimeter and revised cockpit lighting. The first Mirage built to this standard was A3-26, which was delivered to the RAAF in November 1968, after spending some three years with Dassault in France undergoing installation trials of the aforementioned equipment.

The distinction of being the first Mirage IIIO(A) to fly went to A3-61 which took to the air in May 1966; this aircraft was followed by another nine examples with French-built fuselages. It is worth noting that, with only four exceptions all the Mirages delivered to the RAAF during 1967-68 were IIIO(A) variants. One distinctive feature of these aircraft was the absence of the distinctive under-nose bump associated with the Doppler system; Australian examples had their Doppler antenna flush-fitted.

The lack of capability of the Mirage IIIO(F) interceptor model soon became clear and by June 1969, it was decided that remaining examples would be modified to IIIO(A) standard with the installation of the necessary equipment. Converted aircraft were subsequently designated IIIO(F/A) variants. Converted aircraft could be easily distinguished by the adoption of grey/green camouflage in place of their polished aluminium finish. The only early model Mirage to avoid such a conversion was A3-2, which remained with ARDU. By the time the conversion programme was being undertaken, A3-2 had already been extensively modified with flight test equipment to negate the usefulness of conversion to IIIO(F/A) standard. While the last conversions were being performed the final Mirage of the one hundred single-seat and ten dual-seats ordered had made its first flight on November 4th, 1968. A3-100 was delivered one month later, so ending the major part of the Australian Mirage programme. Despite strong attempts to sell the variant to New Zealand, the RNZAF selected the A-4 Skyhawk instead.

The need to introduce two-seat Mirage trainers to the RAAF saw an unusual, if not urgent production plan adopted. The IIIDs differed from the single-seaters in that no fuselages were produced locally; the first IID A3-101 was fully imported from France and made its first flight on October 6th, 1966. Following IIIDs left the Avalon assembly line fitted with imported fuselages and locally-produced wings. Nine of the first ten examples were finally delivered in October 1967. A further batch of six IIIDs was ordered in November 1970, and like the first examples A3-111 to A3-116 had imported fuselages and locally-built wings. They were delivered between August 1973, and January 1974, with A3-116 making its first flight on December 18th 1973, so signalling the end of the Mirage manufacturing programme in Australia.

However, there was to be a continual programme of upgrades and modifications to the fleet. One important modification undertaken was the design and installation in some Mirages of



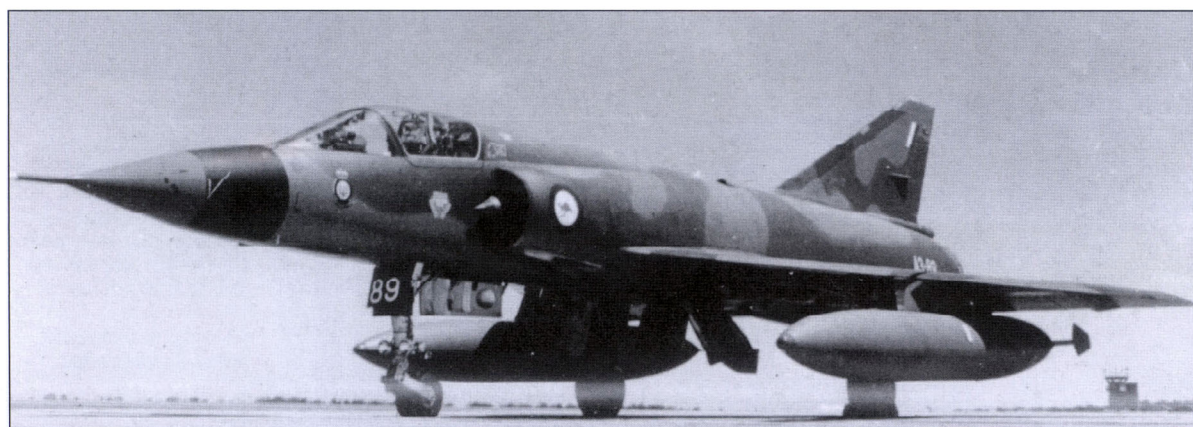
the 'wet' wing leading edge. This gave an additional 55 Imp gal (250 litres) per leading edge. Other improvements centred around the Atar engine. CAC introduced an improved yoke for the afterburner fuel control unit to improve accessibility, strengthening of the nozzle actuating ring, improved electrical connections to the main fuel control unit and a host of other modifications to improve the drive system. Along with production, CAC were responsible for servicing and testing all of the one hundred and forty Atars it delivered.

As the Mirage became operational with five squadrons within the RAAF, a period of instructor and Operational Conversion training was rapidly undertaken, as at the time the Mirage represented a quantum leap over the CAC Sabre it was replacing in terms of performance and capability. No.2 OCU was the first unit to receive twelve aircraft at Williamstown, NSW. A similar number of early Mirages were allocated to ARDU for trials and evaluation work. It was clear from these early days that a revised training programme would be urgently required. For the prospective Mirage pilot, after having completed initial training on the Winjeel, later replaced by the CT-4 Airtrainer, he would undertake an introductory jet course on the Vampire, which was later replaced by the Macchi 326, for elementary fighter tactics and ground-attack training. This course would average about fifty-five hours, after which the pilot would be posted to No.2 OCU, where for the next six months he would fly some 120 hours on Mirage, both dual and single-seat variants, so learning to use the Mirage operationally within a front-line squadron.

Squadron Service

The first RAAF squadron to become operational on the Mirage was No.75 Squadron which commenced operations at RAAF Williamtown in August 1965, before moving overseas to RAAF Butterworth, in Malaysia, as part of Australia's commitment to the defence of the region, in the process replacing No.76 Squadron Avon-Sabres stationed in the region.

With the return of No.76 Squadron from Malaysia it was an ideal time to convert the next RAAF squadron to the Mirage, and in September 1966, at Williamtown the squadron reformed with





Parked between sorties at RAAF Butterworth is this No.79 Squadron Mirage which wears the standard camouflage colours of the time including a high-viz squadron tail band

IIIO(F)s as part of No.81 Fighter Wing along with No.75 Squadron. Over the next few years, as the Mirages increased in number so there was a reshuffling of squadrons between bases to allow for the increase in capability of the new aircraft.

By 1967, the RAAF had four operational fighter squadrons equally divided between No.81 Wing based in Australia (No.75 Squadron and No.76 Squadron equipped with Mirages) and No.78 Wing at Butterworth, No.3 Squadron and No.77 Squadron equipped with Avon-Sabres.

By mid-1967, the squadrons were moved again when No.75 Squadron deployed its Mirages to Butterworth to join No.77 Squadron's Sabres and replaced No.3 Squadron which like the other squadrons before, returned to Williamtown to convert to Mirages. Within six months No.3 Squadron's conversion was completed, but they remained at Williamtown until February 1969, when they returned to Butterworth in place of No.77 Squadron which returned to Williamtown as the final Sabre squadron to convert to Mirages.

By the time all the intended fighter squadrons were suitably equipped the disposition was this: No.3 Squadron and No.75 Squadron were at Butterworth as part of No.78 Wing; No.76 Squadron and No.77 Squadron were at Williamtown as part of No.81 Wing. This distribution of squadrons would remain until 1973, when No.76 Squadron was disbanded as part of overall defence budget cuts at the time. One benefit that these cuts had was to extend the fatigue life of each Mirage, as more aircraft were distributed among fewer squadrons so reducing their individual flying hours. One disadvantage was that these cuts left Australia with just one fighter squadron permanently based in Australia, a situation that remained until No.75 Squadron returned from Butterworth to Darwin in 1983.

However, there was to be one final Mirage squadron formed, although somewhat briefly. In March 1986, No.79 Squadron was formed from remnants of No.3 Squadron at Butterworth, whilst the latter returned to Australia to receive F/A-18 Hornets which were then being introduced to service. Along with the changes in aircraft came a redistribution of fighter squadrons, and the

withdrawal of a permanent squadron at Butterworth saw all RAAF fighter squadrons based within Australia.

The winding down of RAAF Butterworth also signalled the end of No.79 Squadron's brief career with the Mirage, although the aircraft remained with No.75 Squadron at Darwin until September 1988, when like other fighter squadrons they too converted to the Hornet. The significance of RAAF Butterworth can not be underestimated within the overall defence plan of the region by Australia; as if to state the point, when at their peak, No.3 Squadron and No.75 Squadron operated 40 Mirages between them, although this was reduced when No.75 Squadron returned home. In 1983 this was reduced further still with the withdrawal of No.3 Squadron, with No.79 Squadron temporarily filling the gap. With only ten aircraft and eight pilots and lacking much of the specialised ground-support equipment, the squadron continued a highly respectable sortie rate and regularly participated in air exercises in the region.

With their return, No.75 Squadron found itself in the role of air defence of Australia's northern region and by mid-1987 was equipped with 21 Mirage IIIOs and four IIIDs. With such a role it was inevitable that No.75 Squadron's Mirages would be key players in any exercise in the region. They participated last in 'Pitch Black '87', a yearly exercise held in co-operation with the United States. The scenario was to simulate air raids against northern Australia by USAF and RAAF F-111s, Phantoms, B-52s supported by KC-135s and F-4G Phantom II Wild Weasels. Defending Australia were Mirages from No.75 Squadron and No.77 Squadron and the newly introduced F/A-18A Hornets of No.3 Squadron. This was the first time that RAAF Hornets had participated in 'Pitch Black' and would be the last time for the Mirages. Despite their thirty-year age the Mirages gave an extremely good account of themselves and a number of 'kills' were claimed, in particular against F-14 Tomcats when they were reduced to a low-speed dogfight.

Towards the end of their careers Mirage squadrons often took on massive proportions, as was the case of No.75 Squadron, but larger still was No.77 Squadron, which when based at Williamtown had 40 Mirages and 16 Macchi 326s on strength! The reason for such squadron numbers was the disbandment of Mirage training by No.2 OCU, which was passed to the squadron. Along with this No.77 Squadron conducted Fighter Combat Instructor and Introductory Fighter courses. In addition the squadron was tasked with Fleet Support flying following the demise of the Royal Australian Navy's fixed-wing flying element.

Hype and Hazards

Like the Lockheed F-104 Starfighter and its early years in USAF and Luftwaffe service the first generation of supersonic fighters were subject to a higher number of accidents, as former piston-engined veterans and a new generation of pilots came to grips with handling ever faster and higher-flying fighters in an operational squadron; no exception to this was the Mirage IIIO in RAAF service. In all forty Mirages were written off in accidents between December 1964 and March 1987, and fourteen pilots were lost. Though no greater than any other fighter then in service with other nations at the time, the losses were the subject of a vigorous media campaign which to many was uninformed and did little to enhance the Mirage's reputation. Many of these losses occurred when pilots abandoned their aircraft after suffering a problem - which if the pilot's manual was adhered to - instructed the pilot to eject. Such problems included engine failures and undercarriage failure warnings - dead stick landings were not recommended.

One accident that remained in the minds of every Mirage pilot at occurred at Butterworth in July 1976, involving A3-26 and A3-64. Flt Lt Perry Kelly was in A3-26 parked near the

Another experimental scheme depicted on Mirage A3-54. Very often the same shades of greys were utilised but in differing patterns amongst the squadrons



runway threshold awaiting take-off clearance - A3-64 flown by Paul Kay was on finals when it landed on top of the stationary Mirage causing extensive damage. Flt Lt Kelly lost his life in the accident.

Another media rumour that affected the Mirage fleet during its early career was that the fatigue lives of the aircraft were running out of flying hours sooner than expected, and that within a few years Australia would be left with only a handful of Mirages to defend its shores. In truth the problem was far from that serious, but the RAAF were demanding more from their Mirages at a much greater rate than other operators. Compared to the French Air Force who were flying their Mirages once a day, RAAF examples were performing three to four sorties per day! To compound the problem the Mirages were spending most of their time flying at low altitude, which reduced the aircraft's fatigue life dramatically. Dassault representatives expressed concern over the fatigue of the RAAF fleet as early as 1966. On top of this was the intention to replace the Mirage fleet by 1979, but a series of delays in selecting a replacement saw to it that the IIIOs remained in full front-line service until 1986, and then in reduced numbers for a further two years.

With the high usage of the Mirage ARDU's test aircraft A3-2 was modified with strain gauges for its entire life and undertook numerous test flights in an effort to resolve the situation and so pass on a fleet-wide solution. During these flights the RAAF held a joint testing phase with the Swiss Air Force who were in a similar situation. Though tests continued to be undertaken squadrons were not directly affected until 1978, when in theory the Mirages were due for replacement. Cracks in the wings were now appearing, although not so serious as to ground the fleet. A test programme by Aeronautical Research Laboratories (ARL) saw the development of the Boron Patch which was designed to slow down fatigue on the wing/fuselage joint; another solution was to g-limit the aircraft from +7.8g to 5g, and install fatigue meters in all the aircraft.

A more permanent solution to the problem was to refurbish some of the Mirages with new wings. Announced in 1978, this was undertaken along with a general update of the Mirage's systems. The production of the new wings was undertaken by CAC with an additional set of 20 acquired from France. Avionics were updated, engines were brought up to the latest standard, Martin-Baker Mk 4B 'zero-zero' ejection seats were fitted and the Matra R.550 Magic AAM was purchased. With these modifications the Mirage IIIO was finally an interceptor that pilots were proud of, although unfortunately as it turned out it was also near the end of the aircraft's operational life.

Mirage Successor

The search to replace the Mirage IIIO had begun in mid-1970, with another Dassault fighter, the Mirage F1, tipped to join the RAAF; other contenders included the SAAB Viggen, Grumman F-14 Tomcat, Panavia Tornado, General Dynamics F-16, Sepecat Jaguar and the Mirage 2000. In the end the McDonnell Douglas F/A-18 Hornet was selected. However, the Mirage III having gained itself a proven combat record amongst other nations, particular Israel during conflicts in the Middle-East, Israeli Aircraft Industries (IAI) offered an impressive upgrade for the Australian IIIO. Also offered was a re-engine package by Rolls-Royce's Bristol Engines Division which proposed the Mirage IIIO 'Plus'. Their programme was to install an afterburner-equipped Viper turbojet in a pod mounted on top of the rear fuselage, so remounting the Mirage's fin on top of that, not unlike a KC-10 Extender. The fuselage would be zero timed and the forward fuselage would be lengthened to maintain the centre of gravity, and extra fuel tanks would be installed in the extra space. The proposal was speculated to be cheaper than acquiring



a new aircraft and would provide the Mirage with a greater combat endurance and better turning rate than some of the other new types on offer. This was not to be and eventually the F/A-18 Hornet was selected and soon began replacing the Mirage in squadron service. In 1986, No.3 Squadron exchanged its Mirages for Hornets, No.77 Squadron followed in July 1987, No.79 Squadron in April 1988, and No.75 Squadron in September of the same year after some 23 years of continuous Mirage operations. ARDU continued to operate its three Mirages, A3-2, A3-101 and A3-112 on test duties until 1989. The honour of the last RAAF Mirage flight fell to A3-101, a IIID which was flown by Flt Lt Scott Goodier, to Woomera Rocket Range, SA on February 8, 1989 to join forty-six other Mirages which had been placed in storage pending sale to Pakistan. Valued at a cost of A\$2 million each, Pakistan acquired fifty aircraft in 1990, in a deal worth a total of A\$36 million. Included in the deal were forty-five additional Atar 09C engines, a flight simulator and spare parts which were intended to assist a Mirage overhaul plant at Karachi. The first batch of thirty-two Mirage IIIOs were shipped from Wyalla Port, Australia and arrived in Karachi in late November 1990, the balance being shipped to Pakistan by the end of the year. Despite the aircraft being at the end of their fatigue lives and that they required extensive overhaul and structural work to make them airworthy, the Pakistan Air Force (PAF) was confident that the Mirages could be virtually rebuilt and kept in service for another ten years. In the event the PAF pulled off a major strategic coup by acquiring the aircraft that would place it in good stead throughout the late 1990s and early 2000. The Mirage IIIOs were assigned to the air defence role, protecting air bases and other strategic targets, so releasing the hard-pressed F-16s for offensive strike tasks and border patrols.

One of the most spectacular schemes adopted by a few Mirages was this diamond pattern seen on A3-25 of No.75 Squadron; note the black painted radome is retained

The Mirage was the RAAF's first supersonic aircraft and as a successor the Mirage easily filled the 'Sabre's shoes' and was to see longer front-line service than any other fighter, although this may be beaten in years to come by the RAAF's F/A-18 Hornet. Despite the predicted fatigue life of 1,500 hours per airframe some IIIOs flew over 4,000 hours. For those that flew and serviced the 'French Lady' as the Mirage was known within the RAAF, she demanded respect but would never be forgotten. **MAM**

Thanks

The author would like to thank the 'boys at SPASM' for their help in preparation of this article and also Peter Malone, Fred Harris and Gary Byk for allowing me to rummage through their photographic collections. Thanks is also extended to Troy Fosbender who assisted with the RAAF scans.

Further Reading

Further information on the RAAF Mirage can be found in Red Roo Models Publication Profile Number One; 'The Modeller's Guide To The RAAF Mirage IIIO/D.'



SFOR Choppers

by Richard Stickland

1. Gazelle and Lynx from No. 663 Squadron AAC; in total this Squadron has four Gazelles and eleven Lynx in theatre dispersed at several sites. These are at 'The Tom Factory', Gornji Vakuf

Although Bosnia rarely makes the world's headlines at the moment, a six-month tour in the region with one of SFOR's many international contingents is not without its dangers.

The warring factions are now referred to as the former warring factions and incidents of aggression between them or against SFOR are few and far between. Nevertheless, the biggest threat to an SFOR soldier's life is still road traffic accidents (RTAs) and the ever present land mines.

Heavy military policing, which includes the use of speed traps, has caused a big reduction in RTAs and a massive mine clearing programme has ensured that all of the main roads and main tracks have been cleared. More recently the programme has been extended to clearing verges, but despite all this there are still too many RTAs and mine incidents.

To avoid these hazards and to avoid the mountainous roads that get clogged with slow moving military vehicles, the helicopter reigns as the supreme form of transport in Bosnia.

Utility helicopters provide SFOR with the fastest and safest way of moving around theatre. With many (but not all) of the contingents contributing helicopters, the quantities and the types available to SFOR commanders are large. Technologically they vary from the raw Mi-8 Hips to the sophisticated UH-60 Black Hawks. In terms of size they vary from the light Gazelle and Bö.105 that are used to carry two officers or authorised civilians on unscheduled flights to the mighty Chinooks, each of which can be used to move a 105mm Light Gun and its Pinzgauer tractor simultaneously! Or any member of the CVR (T) family such as the prolific Scimitar. The Chinooks are also used for scheduled 'bus runs' around Bosnia, collecting and dropping off squaddies who have been on 'a mission' or who are going on/coming back from R&R.

Some utility helicopters are used for special duties such as air evacuation or at the disposal of special forces. The British have standard utility helicopters allocated to these roles (notably the Sea Kings), whilst the United States have



purpose-built variants of utility helicopters for these roles (such as MH-47E, MH-53J, MH-60K and AH-60 special operations helicopters).

As a muscular peace-keeping force SFOR also has a potent attack helicopter force at its disposal. This role is most successfully filled by the AH-64 Apaches that are operated exclusively by the U.S.Army, but can be called upon by all of the Multi-National Divisions. The British are awaiting their own Apaches, which are being built under licence in the UK by Westland, but in the meantime they use the Lynx AH.7 fitted with weapons pylons and able to carry up to eight TOW missiles and up to four 7.62mm machine guns. [MAM](#)

2 & 3. Two good reasons to use helicopters in Bosnia, a PMR-2A anti-personnel mine and the results of an RTA, the casualty in this instance being a Malaysian Land Rover ambulance



4. Lynx AH.7 fitted with pylons for eight TOW anti-tank missiles at Gornji Vakuf

5. Lynx AH.9 which has wheels rather than the skids used on other Army variants. It has picked up nicknames such as 'Wheelie Bin' and 'Robin Reliant' in Bosnia

6. Lynx AH.7 landing at Glamoc



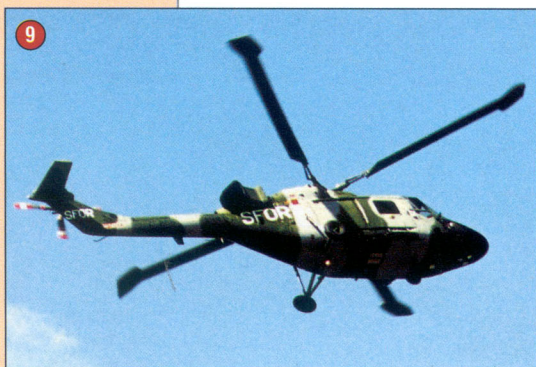
7. XZ221 a No. 663 Sqn Lynx AH.7 taking off from an improvised landing pad

8. Wherever possible SFOR helicopters are armed and carry live ammunition; the Lynx AH.7 is fitted with a GPMG

9. A Lynx AH.9 in flight. The composite blades improve the performance on this variant enabling heavier loads to be carried and vibrations to be reduced

10. ZG886 another Lynx AH.9 at 'The Metal Factory' in Banja Luka, the Headquarters of the British-Led Multi-National Division (South-West)

11. A Lynx lands at Gornji Vakuf to be refuelled





12. One of the two Mil Mi-8 Hips used by the Czech SFOR contingent in Bosnia



13. A Dutch Böhling Böhling coming in to land at eh MND (SW) firing ranges at Glamoc

14. Böhling Böhling from Viper Flight, 299 Sqn, Tactical Helicopter Group, Dutch Air Force. Normally based at Glize-Ryen, but seen here on SFOR service at 'The Metal Factory', Banja Luka



15. A Viper Flight Böhling Böhling refuelling at Gornji Vakuf

16. A Dutch B6105 visiting 'The Tom Factory' at Gornji Vakuf

17. A B6105 lifts off from the AAC's Gornji Vakuf facilities

18. A Sea King from No. 845 Naval Air Squadron coming in to land. No. 845 NAS has four Sea Kings in theatre as part of the Support Helicopter Force, they are based at Split in Croatia

19. An 845 NAS Sea King and a No. 1310 Flight Chinook, both part of the Helicopter Support Force, bringing troops in to the Glamoc firing ranges

20. A Sea King armed with a GPMG over the ranges at Glamoc





21. Airmobile Gunners abseiling from a No. 845 NAS Sea King

22. The RAF's SFOR helicopters are the four Chinooks of No. 1310 Flight, which comprises two aircraft from No. 7 Squadron and two from No. 18 Squadron, both Squadrons being from RAF Odiham

23. A Chinook carrying a light gun into Glamoc

24. As part of the Helicopter Support Force, No. 1310 Flight Chinooks run a 'bus service' around Bosnia; this one is collecting squaddies from Gornji Vakuf



25. Inside an SFOR Chinook during a routine flight; the Gunner is stood behind his machine gun keeping an eye out for trouble

26. At Split the Support Helicopter Group shares its base with the Croat Air force, whose Hips can be seen behind the Chinooks

27. A French Army Gazelle from MND (SE), visiting Glamoc

28-30. Apaches from 1-1 Aviation Battalion, 4 Aviation Brigade, U.S. Army, demonstrating their awesome ability at the Glamoc ranges





31-32. Black Hawks bring General Shinseki (U.S. Army), his aides and his bodyguards into a former school football pitch at Stari Majdan to visit the Czech 6th Mechanised Battalion. General Shinseki is the commander of SFOR



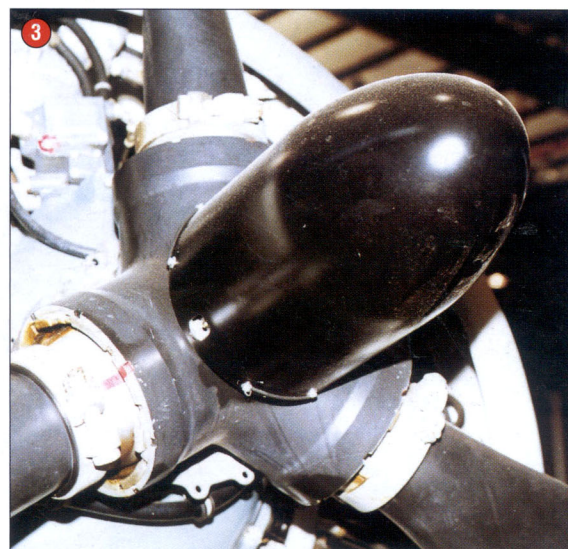


Photo Album

GENERAL MOTORS FM-2 WILDCAT

by Mark P. Attrill

1. Close-up of the area around the engine cowling clearly showing the forward cowling ring and cooler intake, hub and propeller mounting detail

2. This view provides valuable reference detail of the Pratt & Whitney R-1830-56 radial engine, General Electric propeller and the position of the controllable cowling flap doors on the upper surfaces of the forward upper fuselage

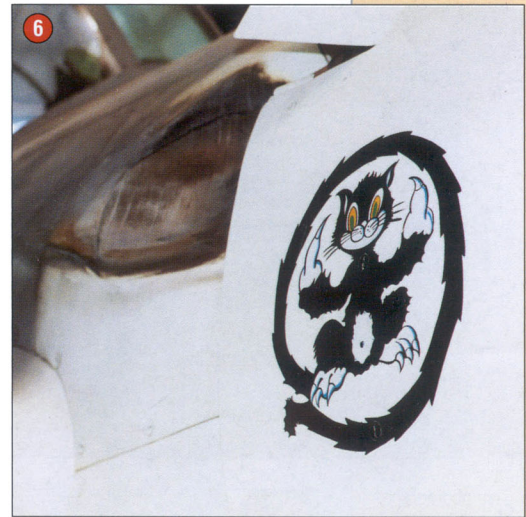
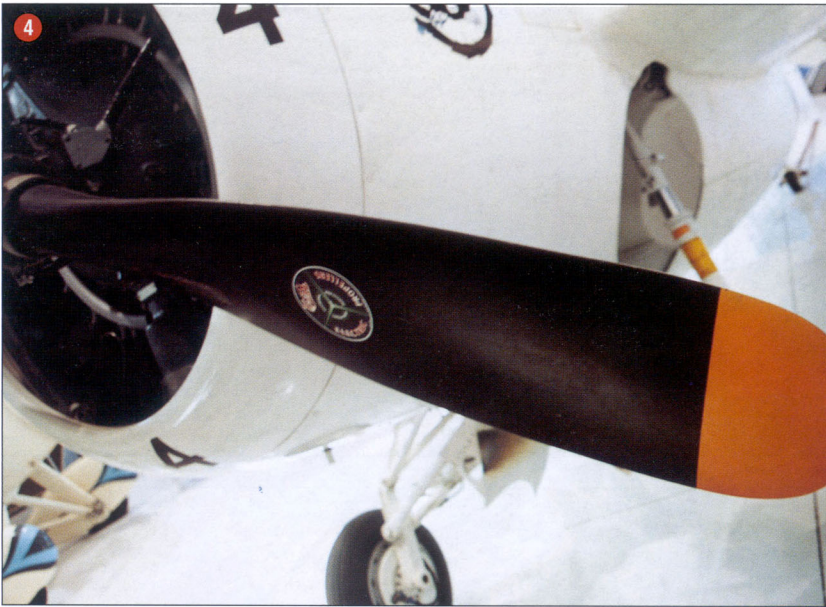
3. Close-up shot of the propeller hub

Opposite Page

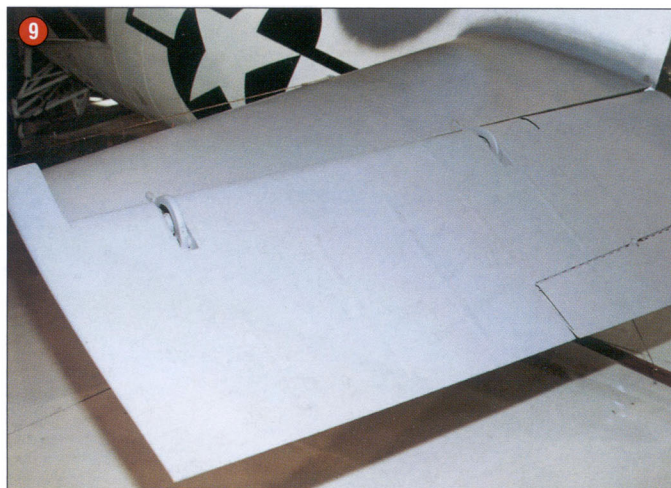
4. This photograph show the shape and style of the propeller blades, which differ considerably from those found on the earlier F4Fs, which had the Curtiss constant-speed propeller

5. Close-up of the famous 'Felix the Cat' badge on the port side of the engine cowling on Grumman Wildcats in the North Atlantic Theatre of Operations

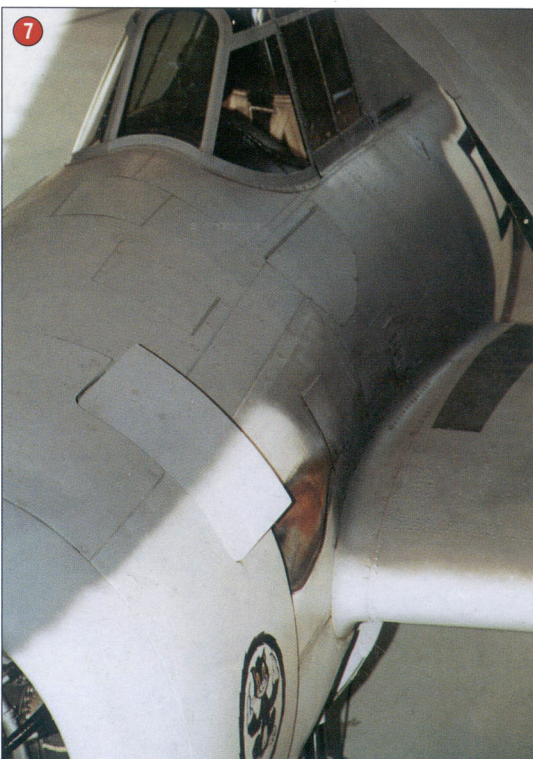




6. Close-up of the badge on the starboard side of the engine cowling. This view also provides useful reference on the shape of the upper exhaust fairings and their heat effect on the fuselage surfaces

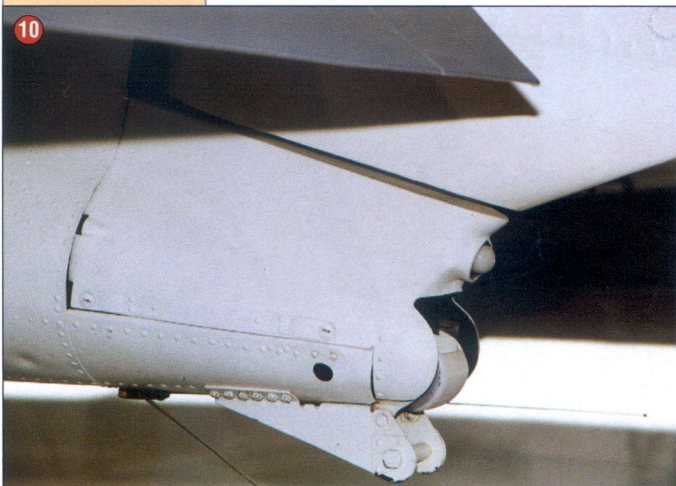


7. Forward upper fuselage which provides some idea of the shape and style of some of the fairings and access panels that adorn this part of the airframe. The photographic angle also demonstrates the lineage of the diminutive Grumman 'Cat' and its clear resemblance to the much bigger Grumman Hellcat

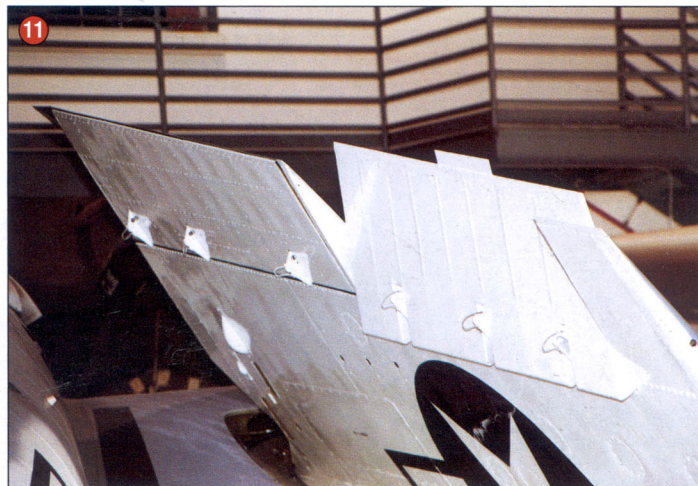


8. The fin and rudder surfaces are clearly discernible in this photograph of Grumman FM-2 Wildcat (c/n 86956) finished in the attractive North Atlantic Gull Grey/White camouflage scheme, quite possibly the most attractive colour scheme to adorn carrier-based USN aircraft during WWII. The FM-2 was the General Motors production version of the XF4F-8, which first flew in November 1942. A total of 4,777 FM-2 Wildcats were eventually built

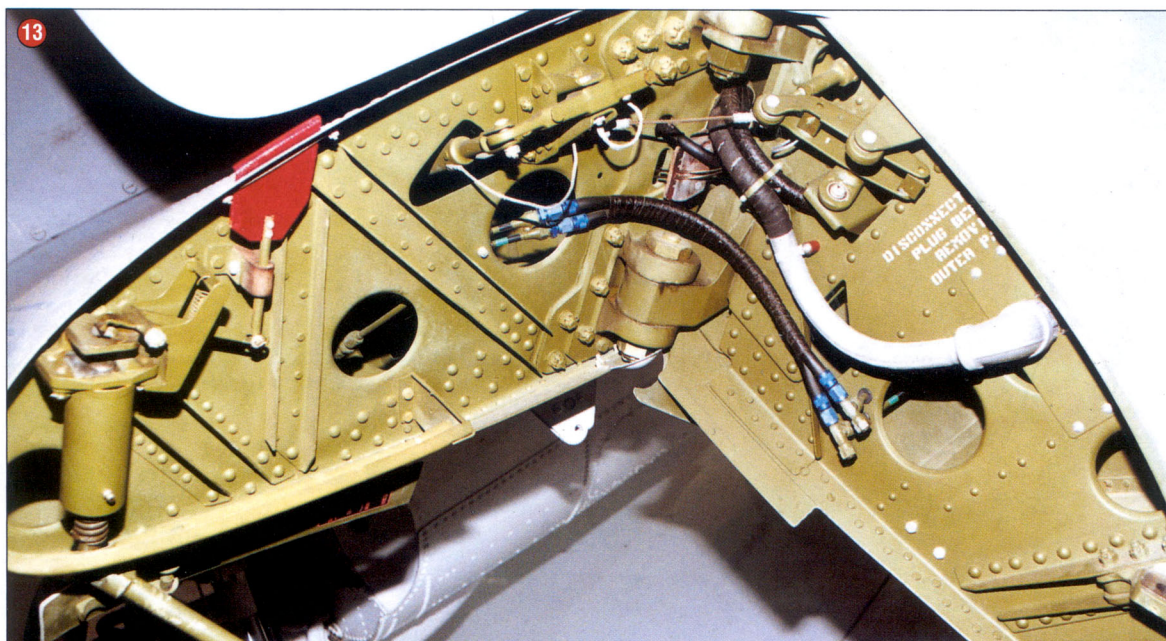
9. Close-up of the tailplane showing the distinctive droop of the port elevator when the aircraft is at rest



10. This photograph provides useful reference for the rear fuselage fairing and the mounting for the arrestor hook

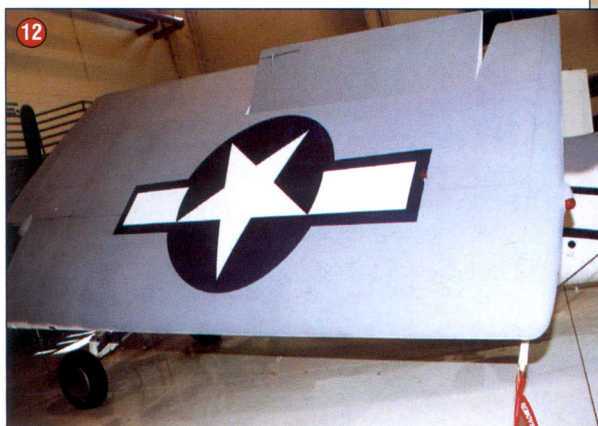


11. Lower surfaces of the starboard mainplane, which has been folded to facilitate storage in the Polk City Aviation Museum. This allows the modeller an unprecedented view of the attitude of the flying surfaces and the hinge mechanisms that adorn the undersurfaces of the wing



12. Upper surfaces of the port mainplane with its immaculately applied North Atlantic camouflage scheme and the large 'stars & bars' markings. Note the position and shape of the pitot tube in the lower left hand side of this view, and the navigation light fairing above

13. An excellent, detailed, view of the wind fold mechanism on the port mainplane. Modellers should note that this reflects the superb restoration of the aircraft undertaken by the team at Polk City. This area on operational aircraft would not have been quite so pristine. Note also the position of the hydraulic pipes and flying controls



14. Close-up view of the port main undercarriage leg and wheel. The position of the oleo is a particularly useful reference point



15. This side-on photograph provides a wealth of detail on the complex structure of the main undercarriage system and bays of the Grumman Wildcat

16. Close-up of the wheel showing the rather simple style of the hub

17. This view shows the shape and style of the main undercarriage fairings, which form an integral part of the legs. The photograph clearly shows the perforations in the inner door structure and the effect the lower exhaust stacks have on the outer surfaces of these doors

18. Lower rear fuselage surfaces showing the position and style of the tailwheel and its mounting

